

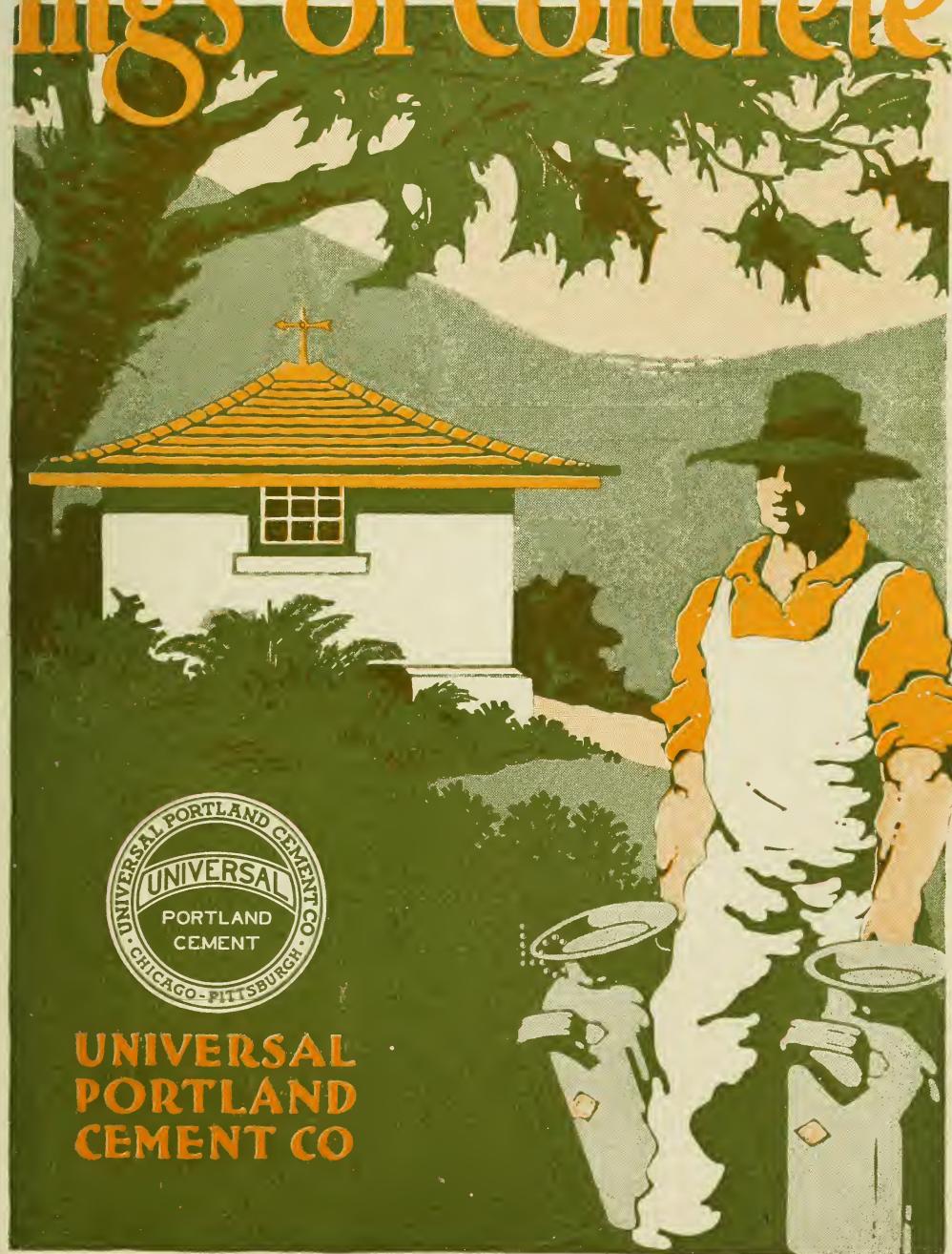
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Small Farm Buildings of Concrete



UNIVERSAL
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Small Farm Buildings of Concrete

A BOOKLET OF PRACTICAL INFORMATION FOR THE FARMER AND RURAL CONTRACTOR

PREPARED BY THE
INFORMATION BUREAU
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ART I of this booklet is intended to furnish specific information on the construction of foundations, floors, walls and roofs of small concrete farm buildings, while Part II gives instructions and plans for putting up dairy buildings, ice houses, hog and poultry houses, root cellars and other similar structures of concrete. The construction of barns, corn cribs, granaries and silos has not been taken up in the present volume. "Concrete Silos," an 88-page booklet by the Information Bureau of this Company, will be sent free to those desiring reliable information on the subject of silo building. Persons seeking information on the subject of concrete barns, corn cribs, or granaries will receive, free of charge, assistance in the shape of suggested plans and general information on request to the Information Bureau.

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Figure 1. CONCRETE DAIRY BUILDINGS

- (1) Concrete Block Dairy House.
- (2) Monolithic Dairy Building with Water Supply Tank, built on the Farm of I. R. Little, Farmer City, Illinois. Dimensions, 12 feet square. Cost, \$200.
- (3) Milk House, Engine and Pumping Room on the Farm of John Arends, West Chicago, Ill. Dimensions, 10 feet x 20 feet.
- (4) Monolithic Milk House on the Farm of Fred Mosedale, St. Charles, Illinois

Small Farm Buildings of Concrete

PART I.

THE five log houses of Plymouth, built by the Pilgrim Fathers nearly three centuries ago, were probably the first substantial buildings constructed by the white man in America. With the advent of the white settlers the log cabin superseded the wigwam of the savages, and during the period when saw mills were scarce and timber plentiful to the point of being burdensome, the log building was the logical—indeed the only possible kind. The sawmill followed the settler and as sawed lumber became more plentiful and the cost of lumber and labor increased, the frame building logically superseded the log building.

Today lumber for many purposes has reached an almost prohibitive figure, and the rapidly diminishing supply gives no hope of future reductions in prices.

Furthermore, in most sections of the United States the best lumber is already used up, and the quality of the future supply will not equal that of the past. Instead of having timber to destroy, as did the settlers of a generation back, the farmer of today finds good timber scarce, and lumber expensive.

Concrete is taking the place of lumber, because, beside all of its other advantages it is cheap, and in every sense of the word economical of home labor and materials. Under a man competent to oversee the work, the most unskilled farm laborer can readily be trained to mix and place concrete properly, while men skilled in carpentry are required to do the work on frame buildings. Most farmers have gravel or sand on the place or can obtain it at small expense, and in many instances, the only material which has to be bought outright is the cement.

The last few decades have witnessed remarkable progress in the manner of raising animals for the market, and in dairying and the growing of crops as well. A few years ago, hogs were protected during the winter only by rude shelters, and in the Northern States, were not marketed until the second year. Because of the lack of protection during cold weather the farrowing season was necessarily short, and the profits of



Figure 2. Concrete Block Building on the Farm of Oliver Jensen, Early, Iowa, containing ice, dairy and store rooms. Dimensions, 16 feet by 22 feet. Cost, \$225.

the hog raising business seriously curtailed. The situation was much the same in the raising of other animals. The introduction of substantial buildings—preferably of concrete—is changing conditions to a remarkable extent, simplifying and lightening labor and increasing profits.

The phenomenal growth of the dairy business in sections of the country adjacent to the great centers of population has brought with it a demand for better facilities for keeping milk and other dairy products clean and cool. To accomplish best results, the concrete milk house or dairy building, equipped with concrete floors and tanks, is necessary. Such a building is cool in summer and warm in winter, is proof against rats and mice, and easily kept clean. It contains no rotting wood construction to form breeding places for germs, and no crevices in which dirt can collect.

The Choice of a Building Material

Requirements of Good Farm Buildings. The most suitable building material is the one which meets the requirements of good farm buildings in the most satisfactory manner, that is, within the limits of allowable expense both for first cost and upkeep. One of the Cornell University bulletins, in discussing the requirements of good farm buildings, enumerates the latter as follows:

1. To keep animals and other objects dry.
2. To maintain a proper temperature.
3. To secure pure air, with a proper degree of humidity.
4. To secure light.
5. To secure cleanliness.
6. To prevent the breeding of vermin (rats, mice, insects.)



Figure 3. A Group of Concrete Buildings, Knollwood Farm, East Norwich, Long Island, New York.

7. To preserve the manure.
8. To secure health, comfort of the animals, freedom from injury, and to prevent the spread of contagious diseases.
9. To secure economy in feeding and watering.
10. To secure economy of space.
11. To secure economy of labor.
12. To secure economy of construction.
13. To secure strength and durability.
14. To secure good appearance.

In addition to the points mentioned in the Cornell Bulletin, the matter of protection against fire is certainly of greatest importance to the farmer and will be discussed at length under the heading "Fire Losses and the Insurance Problem." (Page 13.)

The first requisite is that the building keep out rain and dampness. Animals must be kept dry if they are to be kept warm, and keeping them comfortably warm means the saving of a considerable portion of their energy. Crops and all kinds of farm products, as well as implements and tools, building materials and other articles, cannot be stored in damp or wet places without injury. The second requisite, that of proper temperature is of importance where there are young animals to be taken care of, dairy products to be kept cool, or ice to be preserved.

Pure air is essential to all animal life, and absolutely necessary where dairy products are concerned. Unrestricted sunlight is the greatest enemy of bacterial life, and wherever animals are kept, an abundance of light practically insures freedom from disease. Cleanliness has been placed next to godliness. It is the one paramount requirement where articles of human food are concerned. There is no excuse for the dirty, wooden dairy, or the disease-laden and rat-infested buildings often used to shelter poultry and animals.



Figure 4. Farm Office Building of Reinforced Monolithic Construction. Morgan Farm, Beloit, Wisconsin. An office building is a great convenience on the modern large farm. Even the roof of this structure is of concrete.



Figure 5. WINTER HOG HOUSE SCENES

- (1) Hog House of N. Hampe, Rock Rapids, Iowa. Dimensions, 24 feet by 42 feet. Cost, \$450. Built of Anchor block.
- (2) Charles Klein's Hog House, Rock Rapids, Iowa. Dimensions, 20 feet by 40 feet. Cost, \$450. Built of Anchor block.
- (3) E. F. Hershey's Hog House, Early, Iowa. Dimensions, 20 feet by 40 feet. Cost, \$350.

Economy in feeding and watering is of great importance and includes not only the saving of feed and water, but also the saving of the labor of feeding, as well. Economy of space often involves a saving in the expense of the building and in the convenience of using it. Economy of labor means the lifting of irksome farm burdens, and consequently the shortening of working hours and a larger amount of time for educational and recreative pursuits. While economy of construction is desirable in that it keeps down the first cost of a building, strength and durability are desirable in that they insure permanence and low expense for upkeep. Good appearance is by no means a minor consideration, especially where it can be obtained without additional expense. The days of beautiful landscapes defiled by unsightly structures should be past. Beautiful buildings give the farm an air of home which cannot be obtained by any other means.

How Concrete Meets Requirements. No material meets all of the requirements mentioned in the preceding paragraphs so well as does concrete. Good concrete is water-tight, and a good concrete farm building with a concrete roof is dry, clean, durable and can be made pleasing in appearance, without additional expense. The concrete floor makes the feeding of animals or poultry easy and economical, and the concrete walls leave no place for rodents or vermin. The walls are light in color, reflecting light into all parts. Concrete construction leaves no small corners, crevices, or pockets for dirt to collect.

Logical Design of Farm Buildings.

Perhaps one of the greatest hindrances to progress in the design of farm buildings at the present time is the tendency toward blindly following the design of other buildings in the neighborhood, perpetuating faults and continuing incorrect practice, often with much waste. The crying need at the present time is for logical design. Each building should carefully be planned for the service required of it, considering local conditions but discarding local peculiarities of design, which are often false guides. Additional effort expended to make plans meet, in the best possible manner, the



Figure 6. Monolithic Pump House, Jelke Dairy Farm, Dundee, Illinois. One of several concrete structures on the Jelke Farm.

particular needs in each individual case, is always repaid in the long run in convenience and lower cost of maintenance.

In designing structures to be built of concrete it is often economical to depart from the approved designs for frame structures. This is particularly true in the design of the roof. Concrete roofs may be built quite flat, a pitch of $\frac{1}{4}$ -inch to the foot being sufficient to run the water off. The windows of buildings with solid concrete or cement plaster walls may be put in without sills and lintels. Chimneys and flues may be built up within single or double monolithic or concrete block walls.

Economizing Home Materials and Spare Time. It very frequently happens that a farmer or rural contractor has available at small expense, all of the ingredients of good concrete excepting the cement. In such cases, concrete is certainly the logical material to use in all construction work, because it economizes to the greatest possible degree home resources, employing valuable materials which cannot be used to so great an advantage in any other way.

One of the big problems of farm management is the planning and arranging of work so as to keep the help busy at all times. In spite of the most careful planning, and the most systematic methods of doing farm work, uncertainties of weather and other conditions beyond control make it practically impossible to avoid a considerable loss of time. Such periods may often be used conveniently for doing jobs of concreting. If the weather is too disagreeable for outside work, the time may be spent in preparing the form lumber and arranging details of the work, or in making concrete blocks, sills, posts, slabs or other work indoors.

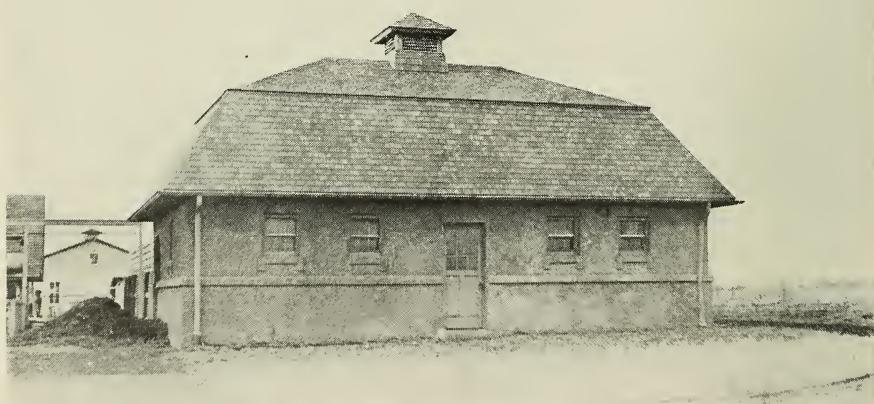


Figure 7. Stallion Barn on Col. G. Watson French's Iowana Farm near Davenport, Iowa. A structure with pleasing lines and convenient interior arrangement.

Fire Losses and the Insurance Problem

Fire Losses. The great majority of farm building losses are from a single source—fire. On American farms alone this terrible agency destroys one-third the value of all farm buildings each year, and these figures do not include the enormous additional losses in time, inconvenience and property, which follow conflagrations as direct or indirect results but yet are not represented in insurance statistics. Insurance experts declare that an average of 500 buildings are destroyed by fire every day in the United States alone, making an average of one building every three minutes, day and night. The money value of this enormous waste has been placed at \$300,000,000, annually, and an additional \$150,000,-000 is spent every year for the maintenance of fire departments, high pressure water systems, and other means of protection against fire. A very small percentage of this latter sum is used however in the protection of farm property.

Ordinary frame farm buildings, far removed from fire protection of any kind, generally meet total destruction when attacked by the flames. This fact has been generally recognized, and as a result, there has been a big demand for fire insurance, which might be more properly known as fire indemnity. The comparatively high insurance rate which farmers are now paying, is based upon the experience that the salvage from fire-swept frame farm buildings is generally small.



Figure 8. Ruins of Dairy Barn and Silo, Crabtree Dairy Farm, Lake Bluff, Illinois, after a fire, November 3, 1910.

Fire Insurance and Fire Protection. It is obvious that fire insurance and fire protection are two entirely different things. The first merely pays the value of the property loss by flames, the other prevents the flames. Fire insurance pays the owner what the burnt portion of his building was worth, but very rarely the sum total of what the fire cost him. It cannot repay the owner for the inconvenience which he and his family may suffer, neither will it reimburse him for the loss of precious time during a busy season, the possible loss or enforced sale of stock, the interruption of business, nor the loss of articles of value as keepsakes. Real fire protection is only possible through fire prevention. It does all that fire insurance cannot do—by preventing the injury, rather than by attempting to make amends after it has occurred.

Preventing Fire Losses. Where fires cannot be prevented, fire insurance is desirable; but given an opportunity to choose between *fire insur-*

ance and fire prevention, the arguments are obviously in favor of the latter. It is equally obvious that the only time to prevent fire is before it appears and it is apparent that the logical method of preventing fire is by building of fireproof construction. Fire fighting apparatus is only effective if used at the critical moment—when the fire starts. The chances of reaching a fire at the critical moment, however, are small. On the other hand, the fireproof building is constantly protected, even though the owner be away from home.

Concrete farm construction is fireproof. In the days when concrete buildings were more expensive, the excuse for not building them was because of their cost. Today, no such argument is possible, for the cost of concrete farm buildings does not greatly exceed the cost of wood in any locality, and in many places it is as cheap as wood; when freedom from insurance premiums and future repair bills is considered,

concrete is actually cheaper than wood. These statements are particularly true when home labor and materials are available.

If the buildings are of fireproof concrete construction they may be placed more closely together thus saving much unnecessary labor. Aside from the consideration of cost, it is probable that no farmer ever doubted the advisability of putting up his buildings of fireproof concrete construction.



Figure 9. Small Gasoline Storage Building, Rochester, Wisconsin, built of concrete block and concrete brick. A very desirable type of building for the farmer with an automobile.

Foundations

Laying Out the Work. Buildings are usually located with reference to some existing object, such as a highway, a drive, or some other buildings. Where the location of the building depends upon some other object, the first line to be determined should be the one influenced by the location of that object. With this established, it may be used as a base line, and the corners which come on it should be located next. In case the building is not located with reference to some other object, the base line should be chosen arbitrarily, and the corners and other lines laid out from it.

One corner will probably be located with reference to some other object, and the other corner on the base line will be located a distance from the first equal to the length or breadth of the building. Mark these by stakes driven in the ground, the exact points being indicated by a nail driven in the stake. These corners are referred to in Figure 10 as "A" and "B," A B being the base line.

After the corners on the base line are definitely located, proceed to locate another corner, marked "C" in Figure 10. The line which runs from "A" to "C", perpendicular to the base line, must first be located. To secure a true right angle at "A" measure accurately 6 feet from "A" along the base line toward "B", and mark this point carefully by a stake and nail, as indicated by "Y". Now measure out exactly 8 feet from "A" in the direction of the corner to be found, and mark a curved line on the ground; measure from "Y" 10 feet to a point on the curved line; drive a stake at this point and then check the measurement, and mark the location accurately with a nail in the stake. This point is marked "Z" in Figure 10. The point "C" will lie on the line "AZ" projected. Corner "D" can be located from "B" the same as "C" was located from "A."

Should the proposed structure be irregular in outline, it will be necessary to project the base line far enough to locate all corners from it. In

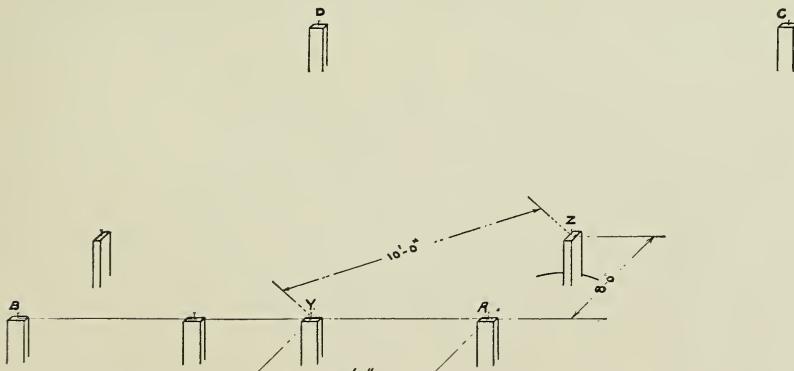


Figure 10. Method of placing stakes for foundation.

such a case three or more points may be located on this line, but the location of the other corners will be accomplished as described.

Locating Construction Lines. After having the corners located it is necessary to establish these points in a way that they will remain permanent during the construction of the foundation, and this is best accomplished by building at the corners, fence-like forms. (Fig. 11). These should be constructed back at least 8 feet from the foundation lines and should be long enough to permit of marking both the inside and outside foundation lines on the horizontal or top boards. Brace the frames sufficiently to withstand the pressure of the tightly drawn cords, which they must support as nearly horizontal as possible.

The points on the corner boards will be located by drawing a cord from one board to the other, bringing it directly over the nails at the two corners on the same line; these points should be marked accurately on the board by a notch, or by cutting a shallow groove with a saw. This cord represents the outside line of the foundation; the inside line will be indicated by measuring in a distance equal to the thickness of the proposed foundation and stretching a cord between these two points. Carefully mark these points on the board in some way different from the marks showing the outside line.

Excavations. With the lines properly located and marked at all corners the excavating may be started. It is usually recommended that a foundation be put down below the point reached by frost, but unless the natural drainage of the soil is poor it will be unnecessary to excavate to a depth of more than three feet, provided solid earth is found at that depth. A foundation must be established on solid ground, all loose earth or loam being removed. Also if "made ground" or a fill be encountered this must be removed to whatever depth is necessary to secure solid earth. Excavating for a foundation until a suitable earth footing is secured may result in an uneven bottom in the foundation trench. Such a condition might prove somewhat annoying if the foundation was to

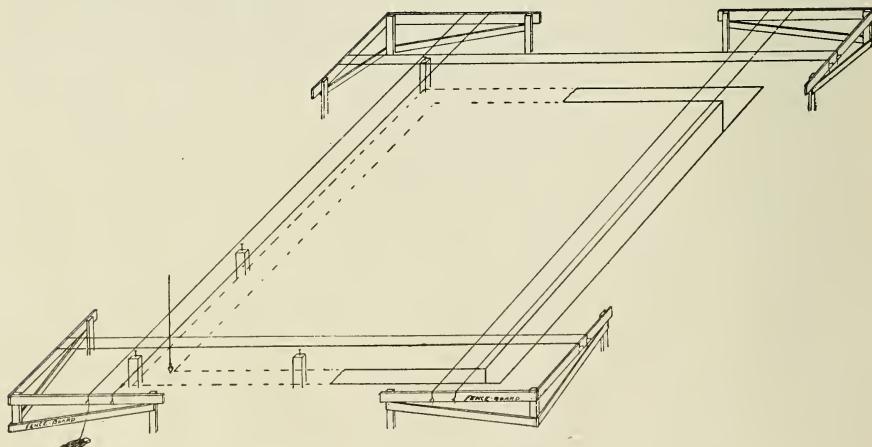


Figure 11. Stakes and Construction Lines indicating location of foundation walls.

be of stone or brick but with concrete the construction will progress the same on an uneven as on an even bottom.

In preparing for a foundation in soil which will stand in a vertical position and when provision for a basement is not necessary, an excavation may be made into which it is possible to place the concrete without the use of forms. When this is practicable, the width of the trench should, as nearly as possible, be the same as that desired for the breadth of the foundation.

When the concrete is to be placed directly into an excavation, care should be taken to protect the edges and to keep dirt out of the concrete. This can be accomplished by placing two or more short pieces of 2-inch lumber across the trench and upon these 2 x 12-inch plank, so placed that they project over the edges of the trench about an inch.

A strip of burlap, building paper, or some similar material should be tacked along the edge of the board on the bank of the excavation opposite that from which the concrete is to be deposited. This covering should hang into the trench far enough to protect the walls at a point where the concrete strikes when dumped from the wheelbarrow.

Forms for Foundations Below Ground. Sometimes because of the nature of the soil, or possibly because a team and scraper are used in removing the earth, the walls of the excavation cannot be kept perpendicular. In such cases forms must be provided for that portion of the foundation below ground, as well as for the portion above ground if there be any.

Unless forms for the whole foundation are to be put up at one time it will be best to build them flat on the ground, in units of convenient length, and then erect them in place. By having the forms constructed in this way they may be removed and used again, with the minimum



Figure 12. Concrete Foundation for a Farm Building, showing method of bracing forms.

damage to the lumber. In building forms flat, the stringers should be carefully leveled and the uprights and sheeting carefully placed in the correct relative position, otherwise the form will be askew when erected.

If the forms are to be built in position, first place the stringer shown at the bottom of the inner form, Fig. 13, so that when the upright 2-by-4's and the sheeting are in place, the inside face of the sheeting will be in line with the inner face of the proposed wall. Nail the lower end of the uprights to the stringer and attach the top board of sheeting to hold the vertical 2-by-4's at the proper distance apart. This frame must now be plumbed carefully and held in place by the braces extending between the upper end of the 2-by-4's and stakes driven into the ground. The remaining sheeting boards may then be placed, starting at the bottom. With so much of the inner form set, the outer one can easily be placed and fastened to the inner one, as shown in the sketch. On account of the small space in which to work, the outer part of the form can more easily be built in sections as described, and lowered into position. When the forms are not to be handled in sections, it will be advisable to "break joints" in placing the sheeting, for by so doing, the form will be somewhat stiffer and the alignment will more easily be maintained. In erecting forms one must bear in mind that they are to be removed and when there is only a narrow space between the forms and the earth wall, provision should be made for their removal by a means which will result in the least damage to the lumber.

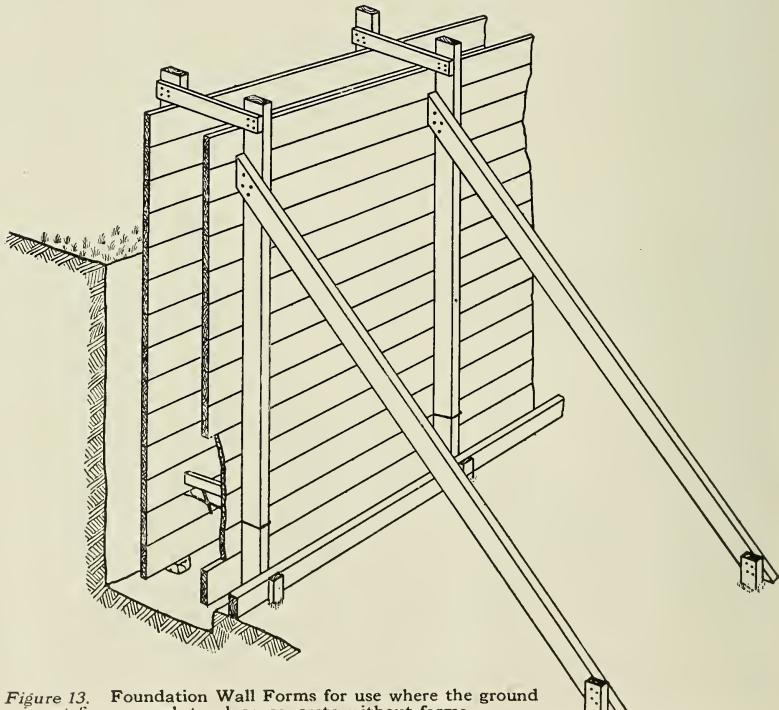


Figure 13. Foundation Wall Forms for use where the ground is not firm enough to place concrete without forms.

It will be noted in the sketch (Figure 13), that the outer form is allowed to rest on stones, so that the lower sheeting board is raised a short distance from the floor of the footing excavation. This allows the concrete to spread out at the bottom of the wall, providing a wider base, which is sometimes desirable.

Instead of supporting the outer part of the form by independent bracing into the earth, it will be better to wire it to the inside section. Spacing blocks of a length equal to the thickness of the wall, should be inserted to keep the two sections of the form in the correct relative position. The wires are then twisted with a piece of iron or a large nail, until the outer section is drawn against the spacing blocks. The top of the uprights are fastened together with cleats (K), as shown in the sketch. If the wall is high it may be necessary to put in additional wires and blocks near the center of the uprights.

Some means must be provided for removing the spacing blocks as the concreting progresses. This can be done by attaching a wire to the block by which it can be withdrawn after being knocked loose.

Figure 14 shows a type of form to be used when a wide base is wanted. This provides for a batter on the outside face of the foundation. The details of construction are the same as given for Figure 13 with the exception that the bottom sheeting board on the outer form is allowed to rest on the floor of the excavation. In case it is desirable to make that part of the wall extending above the ground level plumb, small wedge-

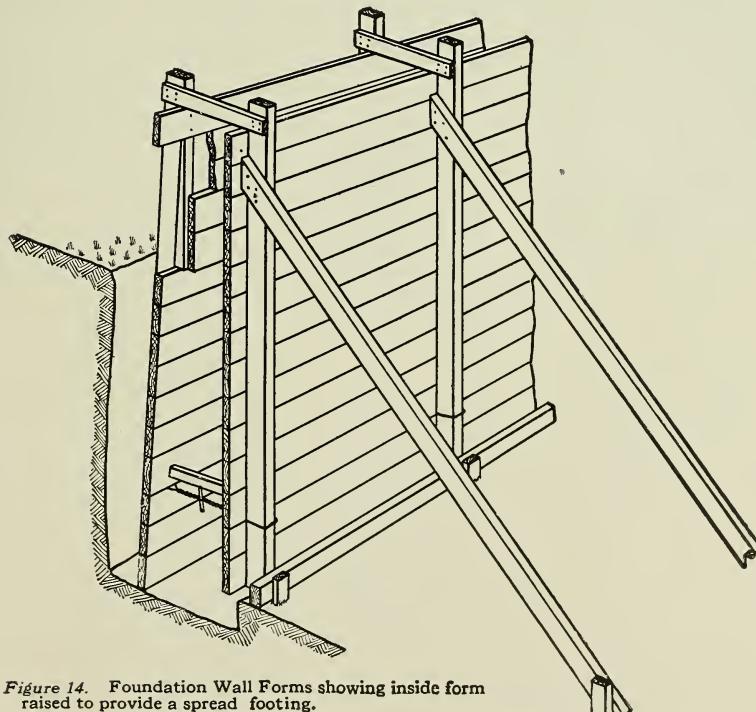


Figure 14. Foundation Wall Forms showing inside form raised to provide a spread footing.

shaped blocks can be attached to the 2-by-4 uprights of the outer form, and the sheeting nailed to these blocks.

In Figure 15 is shown a type of form used when the character of the soil will permit of placing concrete directly against the earth, doing away with that part of the outer form below the ground level. The inner form is erected as described in Figure 13 and the concrete placed up to within a few inches of the ground level. When depositing concrete in this type of form, care must be exercised, as dirt is likely to be knocked off the sides of the bank into the concrete. The edge of the excavation should be protected with boards, as previously described. The small outer form is built in sections and set up as shown in Figure 15 and the concrete for the remainder of the wall placed in the usual manner.

It will be noted that all forms can be built with stock length lumber, requiring very little sawing, which permits of the lumber being used later for other purposes. If a smooth face is wanted, dressed lumber should be used.

Foundations Above Ground. Foundations for monolithic and concrete block structures need not be carried up above the ground line, as is customary with cement plaster, frame and brick buildings erected on a concrete base. Where the walls are to be continued up of monolithic concrete or concrete block, the top of the foundation should be leveled off, so that the forms for the walls may conveniently be placed thereon. The top of the foundation should not be trowelled, as trowelling makes

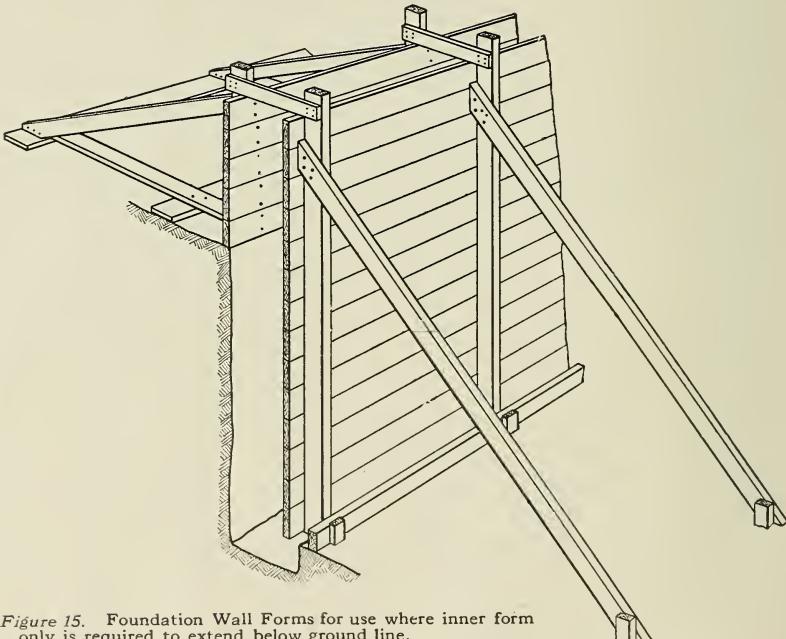


Figure 15. Foundation Wall Forms for use where inner form only is required to extend below ground line.

it more difficult to secure a good bond between the foundation and the wall proper, when the latter is to be continued up.

It is quite desirable, of course, that the floor of all buildings be somewhat higher than the surrounding ground level, and to make this possible it is customary to carry the foundation of buildings other than monolithic and concrete block, a short distance above ground. For this purpose, forms are required. Suitable types of forms for projecting the foundation walls above ground are shown in Figure 16.

The forms shown in Figure 16 can either be constructed in sections and then set into position, or built in place, depending somewhat on local conditions. If the inner and outer parts of the form are built separately, in sections, they may be leveled carefully and plumbed as units, while if built in position, care must be taken in placing each timber. In all cases the bottom boards of the sheeting should be flush with, or a little below the top edge of the trench. The top boards of the sheeting should be the height of the finished wall.

From the figure it will be noted that the forms are suspended over the trench and not allowed to rest on the new concrete. This is accomplished by placing stringers on the ground a short distance back from the trench, supporting the triangular frame bracing.

If the building is of large dimensions, considerable lumber will be required to provide forms so that the whole job can be executed at one time, therefore it will be found cheaper to build the forms in sections the stock length of the sheeting boards. Four to six sections will be ample, unless a large force is employed. The forms can be removed and used again when the concrete has hardened sufficiently. By planning the work in this way a small amount of lumber will make all the forms necessary for the foundation of a large building.

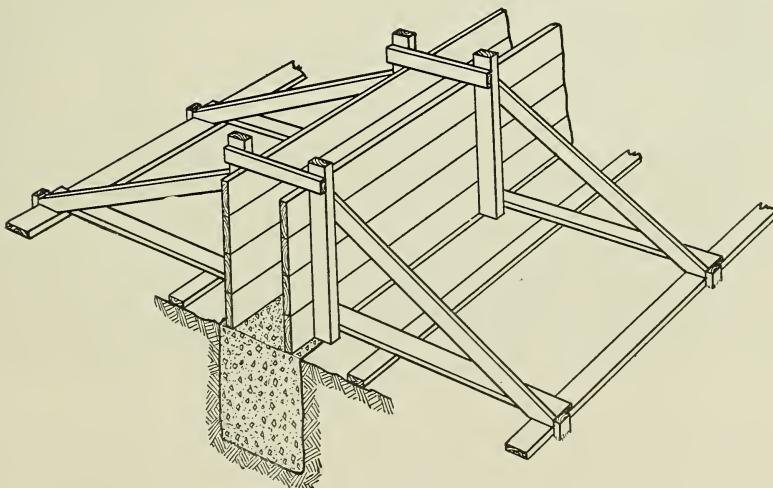


Figure 16. Form for Foundation Wall above ground.

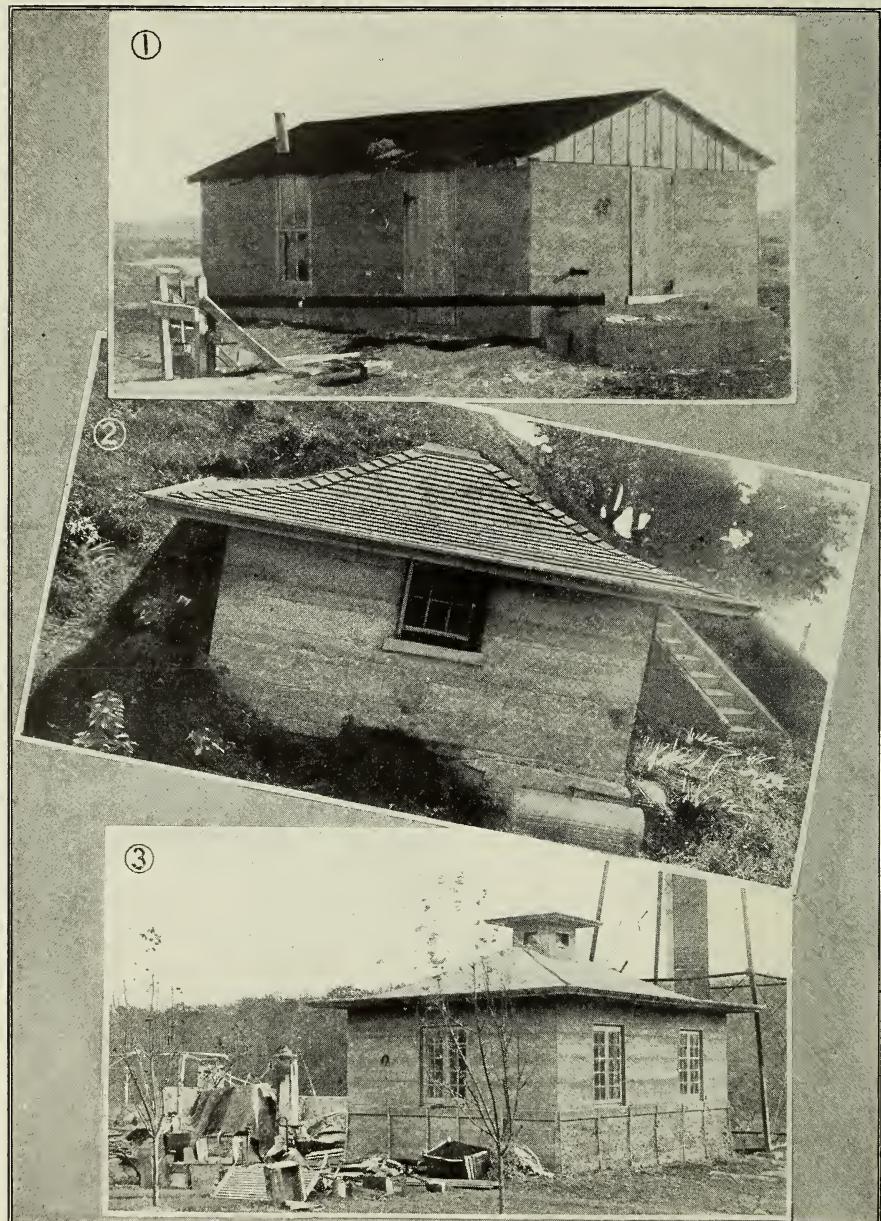


Figure 17. CONCRETE PUMP HOUSES

- (1) On George Lee Tenney's Ranch, Grover, Colorado. Dimensions, 14 feet by 26 feet. Built by the owner at an expense of \$32.55.
- (2) On the Morgan Farm, Beloit, Wisconsin.
- (3) On the Crab Tree Dairy Farm, Lake Bluff, Illinois. The only building left standing after a recent fire.

Concrete Floors

ONE of the most important parts of any concrete farm building is the floor, and there are many reasons why it should be of concrete. The principal considerations are those of convenience, sanitation and cost and on all three of these points a concrete floor has practically no rivals. There is no excuse today for the rotting, germ infected wooden floors formerly so common to farm buildings, with their uneven surfaces and occasional broken boards and rat holes. Wooden floors are seldom properly drained, owing to the fact that it is impracticable to make and keep them tight. Drainage is easily provided with a concrete floor, assuring good sanitation.

The first thing to consider in the building of a floor is the character of the soil to be covered. Sometimes when the soil is heavy and holds water, a sub-base or foundation of gravel or cinders is advisable, but when the soil has good natural drainage, the sub-base is not necessary. If a sub-base is desired, excavate the area to be covered by the floor to a sufficient depth to permit placing 8 inches of gravel or cinders beneath the floor. The gravel or cinders should be packed well by thoroughly wetting and tamping. Forms will not generally be required for the floors of small buildings, but in cases where are necessary, they should be made of lumber 2 inches thick. One-inch material requires more stakes and cannot be kept in as good alignment as heavier stuff. Floors of farm buildings are generally made 4 inches to 6 inches thick, for which 2 by 4-inch or 2 by 6-inch form lumber should be used. If the floor is to look well when completed, care must be taken to place and keep the forms straight and even and they should also be leveled carefully.

Drainage. For the purpose of securing good drainage the floor should be made to slope toward some suitable point; a quarter inch to the foot is ample slope for this purpose. In small milk houses the floor may be sloped toward the tank, and the water conveyed to an outlet

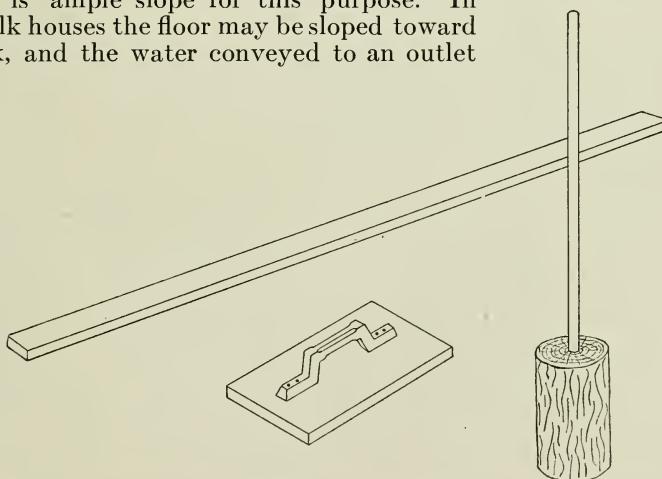


Figure 18. Straightedge, Wooden Finishing Trowel and Wooden Tamper.
Home made tools required for laying floors.

by a small gutter running along the floor close to the tank, as shown in Figure 65 on page 78; ice house floors should drain to a central outlet, piped so as to prevent warm air from entering the ice chamber (see Figure 65, page 78); floors of poultry houses and similar structures may drain to the outside or to a center drain as desired, while the hog house floors should be provided with gutters at the sides of the feeding alley. Before beginning the actual construction of the floor, the manner of draining must be decided upon, and plans laid accordingly.

Mixing and Placing the Concrete. For the body of farm building floors in general, a mixture in the proportion of 1 sack of cement to $2\frac{1}{2}$ cubic feet of clean coarse sand and 4 cubic feet of screened gravel or crushed stone will be found suitable. Sufficient water should be used in the concrete to produce a mixture which when placed will show moisture readily on the surface. After the concrete is mixed, the quicker it is tamped into place the better. It must be placed before showing the least tendency to harden, and under no circumstances should the concrete be allowed to stand longer than half an hour.

The concrete base is usually covered with a mortar finish coat $\frac{3}{4}$ -inch to 1-inch thick although the surface coat of mortar for the floors of farm buildings is considered unnecessary by many persons. If not to be given a mortar finish coat, the bases of the floors of hog and poultry houses, ice houses, and similar buildings should be finished up with a wooden trowel, adding a small amount of mortar, if necessary, to improve the surface. With ordinary care, this treatment will give a surface sufficiently smooth for the purposes required of it, and at the same time rough enough to prevent persons or animals from slipping.

The Surface Coat. In such buildings as dairy houses it is generally desirable to give the floor a mortar top $\frac{3}{4}$ -inch to one inch thick. This



Figure 19. An excellent type of ventilated Concrete Block Corn Crib. Charles Griesemer, Hopedale, Illinois.

should be laid directly upon the tamped base while the latter is still wet and before it has hardened. Great care must be exercised in preventing sand, dust, clay or other foreign matter from getting into the base while it is exposed, for such material invariably prevents a good bond between the top and the base. The mortar for the top should be mixed in the proportion of 1 sack of cement to 2 cu. ft. of sand, sufficient water being used to make the mass spread easily. The mortar should be mixed in small quantities and placed as quickly as possible.

Mortar must never be used in the surface coat after it has started to harden. The spreading of the top should be done with a trowel and a straight edge, the latter being required in working the surface to a true grade. The top should be distributed over the base and worked to a uniform surface with as little trowelling as possible. A convenient straight

edge is shown in Figure 18. It should be made of a piece of dressed lumber $\frac{7}{8}$ -inch thick by 4 inches wide, and long enough to extend between forms. By careful use of the straightedge during the process of spreading and trowelling no difficulty should be experienced in obtaining a true surface, free from dips and hollows.

After the top is spread evenly, it is

sometimes necessary to wait a little while before finishing it, but the top must not be allowed to stand too long, for after standing it may require excessive trowelling to get the finish desired. Excessive trowelling frequently causes checking which disfigures the work and also produces a surface which is smooth and slippery. Smoothing with a wooden trowel will leave the floor in much better shape than with a steel trowel. When the surface of the floor has been properly graded and has received sufficient trowelling, it should be marked off into blocks, not larger than 5 feet in either dimension. These marks should first be made with the point of a trowel and then worked down with a groover, which with an edge runner are the only finishing tools necessary that cannot be home made. (See Figures 18 and 20.)

After the walk or floor is finished it should be protected until it is thoroughly hardened. It should not only be protected against traffic, but against rain, frost or too rapid drying out. An excellent practice for out-door work is to cover with fine earth or sand as soon as the work will permit of such covering without being disfigured.

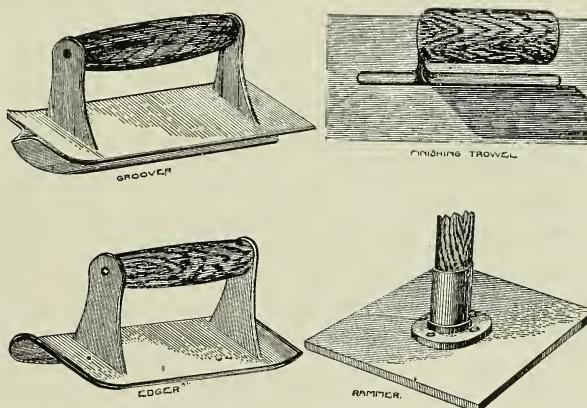


Figure 20. Steel Rammer, Finishing Trowel, Groover and Edger for finishing floors and sidewalks.

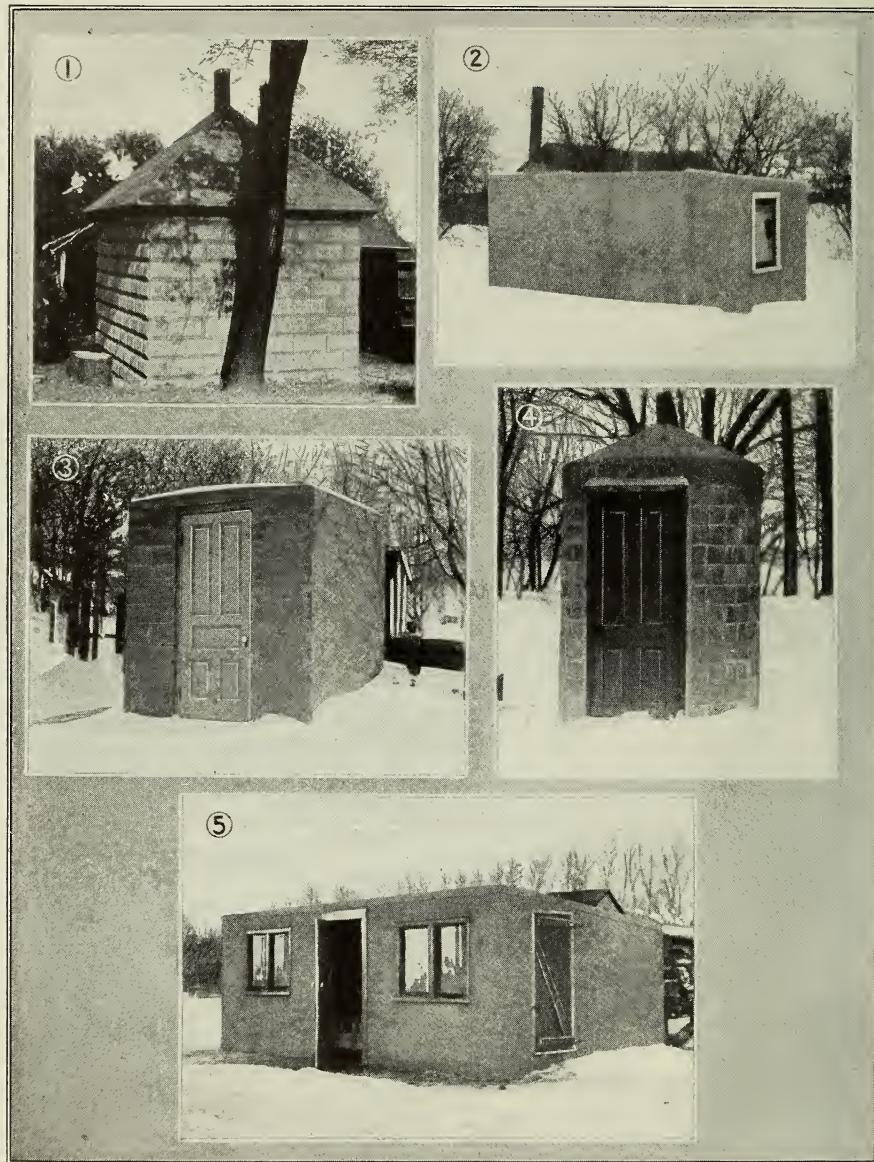


Figure 21. SMALL CONCRETE BUILDINGS ERECTED BY OWNERS

- (1) Smoke House of Sam. Meyer, Bloomingdale, Illinois. Dimensions, 12 feet square.
- (2) Bath House of W. S. A. Smith, Sioux City, Iowa. Dimensions, 10 feet by 10 feet.
- (3) Smoke House of John Schram, Early, Iowa. Dimensions, 8 feet by 8 feet.
- (4) Circular Smoke House of George Rosenhauer, Early, Iowa.
- (5) Poultry House of W. S. A. Smith, Sioux City, Iowa.

Stairways and Steps

IF the building is to have a basement, or if it is to be more than one-story in height, concrete steps, or stairways, will need to be provided. This work can be accomplished easily, and with the minimum amount of form lumber, by following the procedure laid down in the following paragraphs.

Basement Steps. The first step is to excavate the required space, after which the forms should be erected for the side or retaining walls. Simple forms, as shown in Figure 22 will answer. There is an advantage of building these forms in place, and bracing them rigidly, one against the other at the top and bottom; a smaller amount of lumber will be required, however, if one form is used first on one side and then on the other, bracing against the opposite wall. After the first side wall has become sufficiently strong, the forms are removed, the cleats are reversed, and the forms reset on the opposite side.

When in position, the forms for the side walls will rest upon the floor of the excavation made for the steps. As the walls will project above the ground at the building line and slope from this point to the opposite end of the entrance, an outside, rectangular form will be required for this portion, and should be constructed and established the same

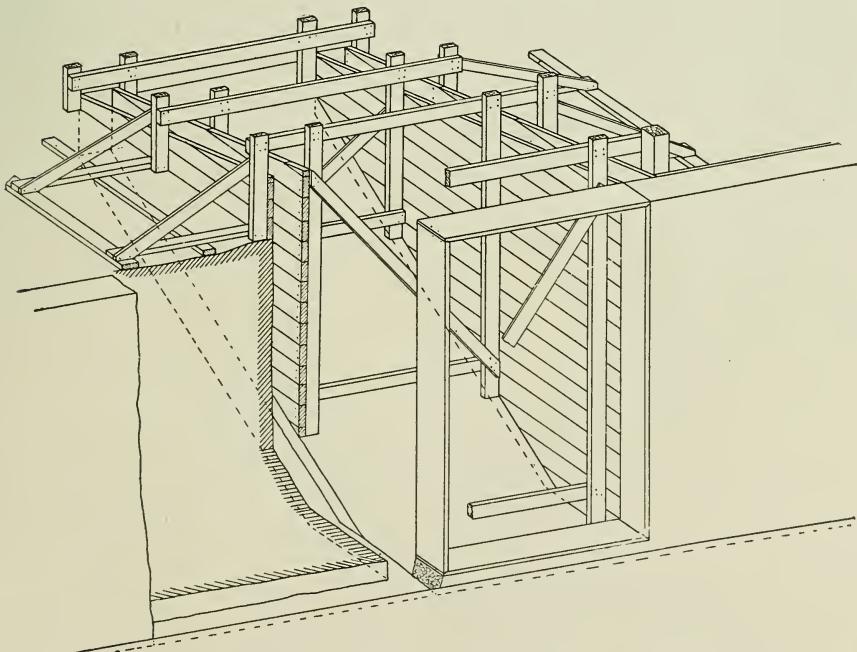


Figure 22. Forms in position for retaining walls for cellar steps.

as the form shown in Figure 16. The top of the inside form is attached to the outside form, and, in a small way, will help to support it. It will be noted that the sheeting boards are placed horizontally, for by so placing them, less cutting is required and, therefore, less waste of lumber.

If the forms for the side walls are put up so that both can be filled at the same operation, each should be braced rigidly at the bottom against the side of the excavation while the other is being filled. After the concrete is in place on one side, the braces within the forms on the opposite side must be removed only as the concrete is placed, for by the pressure of the green concrete on one side, both forms will be pushed out of line unless sufficient bracing is maintained until the pressure is equalized by the concrete in both forms.

Step Forms. The best type of form is shown in Figure 23. Cross pieces are wedged between the side walls and assisted by a bracing, supported from a frame, also wedged between the walls. For a starting point mark on the side wall the position of the top of the finished landing, which should be the same elevation as the basement floor, (Figure 24). Measure out along this line from the face of the building wall a distance equal to the width of the proposed landing, less the thickness of the material to be used as cross forms; this point will be designated as "Q." From "Q" measure vertically a distance equal to the rise of one step; this point which will be referred to as "R" indicates the point to which the upper outside corner of the cross form will come.

Locate a point at the junction of the face of the side wall with the building wall, a distance from the level of the finished landing equal to the rise of four or more steps; measure

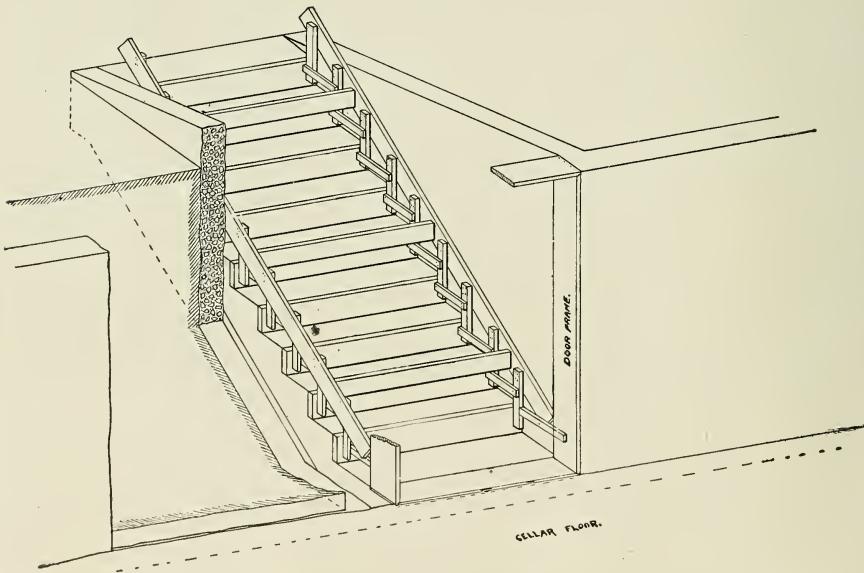


Figure 23. Method of laying out forms for cellar steps.

out from this point in a horizontal direction a distance equal to the tread of one less number of steps than used in getting the elevation, plus the width of landing, less the thickness of the riser form; this point will be known as "W." Draw a line along the face of the wall through "R" and "W." Starting at "R" the distance "X" between points can be selected from Table "A." After these points are located, project a vertical line through each by the use of a plumb level.

Table A

Distance "X." (See Figure 24)

Rise in Inches	TREAD IN INCHES							
	8½	9	9½	10	10½	11	11½	12
6	10 $\frac{3}{8}$	10 $\frac{1}{2}$	11 $\frac{1}{4}$	11 $\frac{11}{16}$	12 $\frac{1}{8}$	12 $\frac{1}{2}$	12 $\frac{15}{16}$	13 $\frac{7}{16}$
6½	10 $\frac{3}{4}$	11 $\frac{1}{8}$	11 $\frac{1}{2}$	11 $\frac{15}{16}$	12 $\frac{7}{16}$	12 $\frac{13}{16}$	13 $\frac{3}{16}$	13 $\frac{11}{16}$
7	11	11 $\frac{1}{16}$	11 $\frac{3}{8}$	12 $\frac{3}{16}$	12 $\frac{11}{16}$	13	13 $\frac{7}{16}$	13 $\frac{15}{16}$
7½	11 $\frac{5}{16}$	11 $\frac{11}{16}$	12 $\frac{1}{8}$	12 $\frac{1}{2}$	13	13 $\frac{5}{16}$	13 $\frac{11}{16}$	14 $\frac{3}{16}$
8	11 $\frac{11}{16}$	12	12 $\frac{3}{8}$	12 $\frac{13}{16}$	13 $\frac{5}{16}$	13 $\frac{5}{8}$	14	14 $\frac{7}{16}$

The cross pieces which are held in place by wedges, should be cut about a quarter of an inch shorter than the distance between the walls. In placing these bring the face flush with the vertical line, the upper outside corner coming to the point located on the line "R."—"W."

In addition to wedging, which should be sufficient to keep the cross pieces in a true horizontal position, bracing, as shown in Figure 23 is desirable to keep them from being pushed out when the concrete is

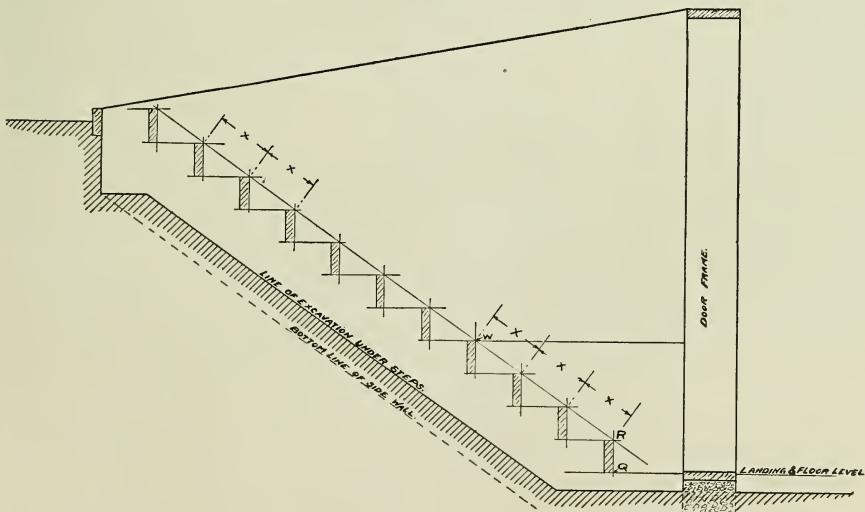


Figure 24. Method of laying out basement steps.

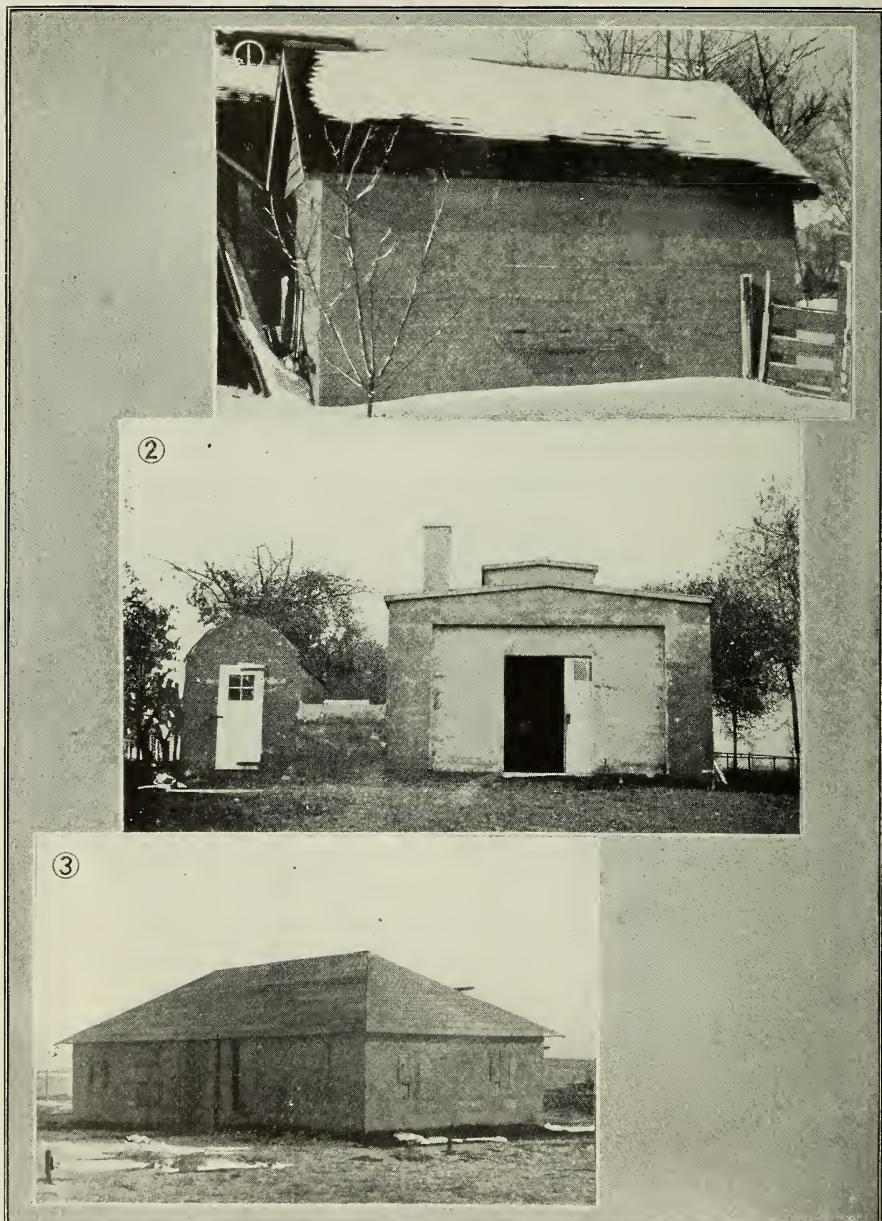


Figure 25. CONCRETE FARM BUILDINGS.

- (1) Concrete Building on Farm of E. P. Barringer, Ruthven, Iowa, which serves the purpose of a bee house, smoke house and safety deposit vault combined.
- (2) Concrete Smoke and Slaughter House, Gedney Farms, White Plains, N. Y.
- (3) Ranch House of George Lee Tenney, near Grover, Colorado. The house is shown closed up for the winter, the owner occupying the ranch only during the summer. Mr. Tenney has several other examples of good concrete work on his place.

placed. It will be noted that the upper ends of the vertical pieces supporting the cross-forms are nailed to pieces which are held tightly against the walls by braces between them. This frame should be built in place, as better results will be obtained than if placed after building.

Walls for Concrete Farm Buildings*

SEVERAL types of concrete walls are successfully used for farm buildings, each type having its particular advantage, while all possess in common the general advantages of concrete construction. Monolithic walls are built either plain or reinforced. Block walls are built of hollow or solid block or frequently of concrete tile where this product is obtainable. Another type of wall is constructed of concrete posts or columns, and slabs cast in forms on the ground and afterwards assembled. Plaster walls are built with three or more coats of cement plaster applied to metal lath. All of these types will be discussed and suggestions for their construction given.

*Limited to walls of one story structures.



Figure 26. Implement House, Echo Valley Farm, Odebolt, Iowa. A substantial and pleasing structure with ample capacity for the farm implements and tools. Dimensions, 24 feet by 48 feet.

Monolithic Walls*

MONOLITHIC or solid concrete walls are built single, or double with an air space. The single walls are recommended for all structures except ice houses. Except for the building of the forms, single monolithic walls of moderate height require practically no skilled labor. The lumber used for the forms, if carefully handled, is available for some other purpose. Double walls consist simply of two single walls, usually built up simultaneously, with a small air space between. This air space is made as narrow as can be constructed conveniently, the width generally being from three to six inches. Monolithic walls permit of a wide variety in design, and in this construction irregular shapes may be made without limit, depending upon the skill of the builder in providing the necessary forms. The essentials for building good monolithic walls are: Well made, substantial forms, properly proportioned and thoroughly mixed materials, and care in placing the concrete in the forms and protecting it until hardened.

*The word "monolithic" coming from "mono" meaning one, and "lith" meaning stone, is used in concrete work to denote the objects of concrete which are one continuous solid mass, or "as one stone."

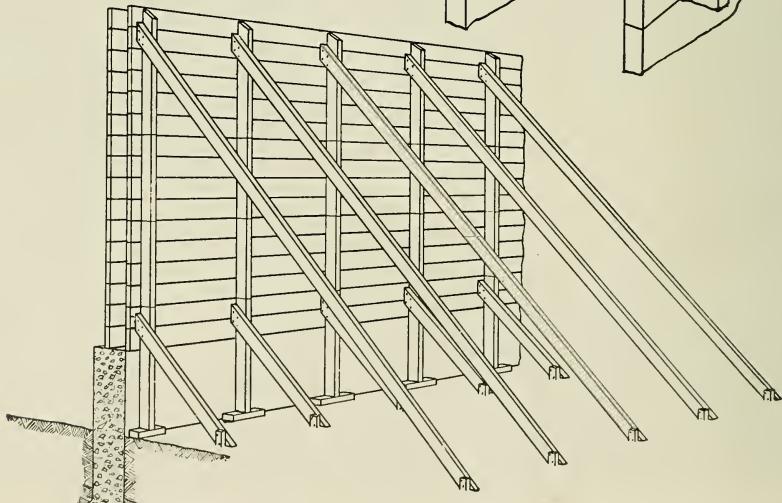
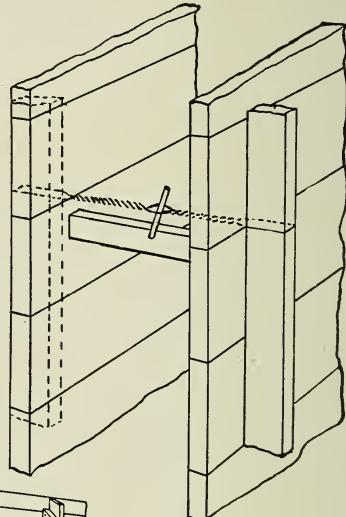


Figure 27. Ordinary wooden wall form supported from the ground and method of spacing forms.

Forms for Single-Wall Monolithic Work. There are two general types of forms available for the construction of monolithic concrete walls; wood forms built for a large section or the entire wall before concreting is begun, and wood or metal portable forms which are erected in sections as the work progresses. Forms of the former type are built in place and are supported by framing from the ground. If carefully handled the lumber in such forms need not be damaged but may be used for some other purpose later. Forms of the latter type are supported by the wall. They may often be purchased from the manufacturers but where constructed of wood, they may be built at home. These forms can be used a number of times and may quickly be removed and reassembled. They make a large saving in the amount of lumber needed and for this reason are especially recommended to the farmer.

In the selection of lumber for the construction of forms white pine is considered the best, but for work of minor importance, the cheaper kinds, such as spruce, fir and Norway pine, may be used. Stiff lumber is best adapted for struts and braces. All lumber to be used in the face of the forms should be free from loose knots and tendency to sliver, and should be surfaced on one side and both edges. For smooth work tongue and grooved stuff will give the best results.

For wall forms, two-inch stuff is recommended as lighter material springs out of alignment easily and requires closer spacing of studding. The lighter lumber also warps badly and is soon inconvenient to handle.

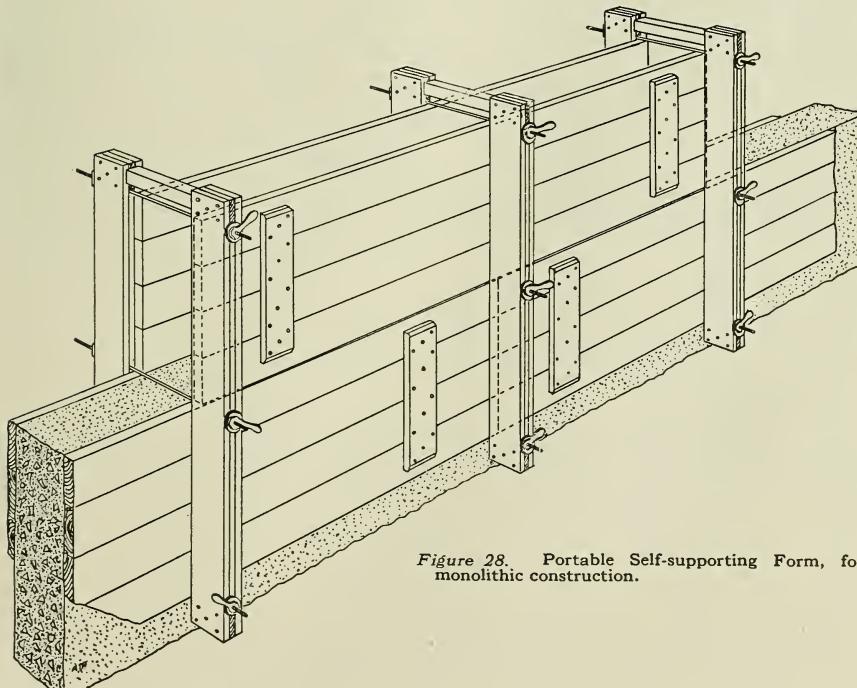


Figure 28. Portable Self-supporting Form, for monolithic construction.

For ordinary wall forms, two-inch lumber requires studding spaced about three feet apart. The construction of forms in the field should be planned carefully so that the lumber will cut with the smallest waste. The form boards require only light nailing to the studding, as the outward pressure of the concrete will hold them in place as soon as the forms have been filled. A uniform distance between forms is maintained by separators, and twisted wires passed around the studding as shown in Figure 27, upper view.

Forms for Double Wall or Hollow Wall Monolithic Work. In the construction of buildings such as ice houses, where it is necessary that good insulation against heat be provided, double wall or hollow wall monolithic work is often preferred. Double wall work, as the name implies, consists of two entirely separate walls, one constructed outside the other with a space between. To construct double wall monolithic work a special type of wall form is required unless the air space is sufficiently wide to accommodate two single wall forms back to back. The hollow wall may be constructed with the aid of cores placed in the forms and later withdrawn, or by placing in the center of the wall, tile or other similar material capable of producing an air space.

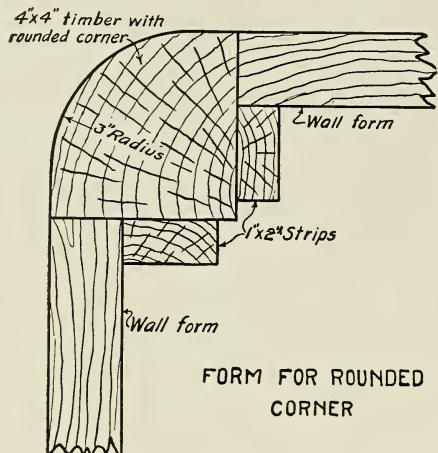


Figure 29. Form for rounding the inner corners of building walls. Rounded corners prevent the accumulation of dirt and simplify cleaning.

made up of one-inch stuff nailed to the flat side of 2 x 4's will generally suffice if held apart by some type of convenient spacers. The sections should be made up in sizes which will conform to the outer forms, and should be planned carefully so as to expedite removing from the walls and handling.

A convenient type of inner form spacer is shown in Figure 30. The spacer may be made of 2 x 4-inch material sawed through diagonally as shown, and held together by small stove bolts traveling in slots. The sides of the spacers are held to one of the inner forms by pegs which rest in screw eyes. The inner forms are then spaced at proper distances apart by the wooden spacers between the inner and outer forms, the wedges of the spacers are driven down into position and the nuts on the stove bolts tightened. As soon as the concrete in the walls is sufficiently strong the stove bolts are loosened, the wedges driven up, and the spacers removed. The forms can then be pulled off easily if they

were properly painted with whitewash or crude oil before placing in position.

Runways and Scaffolding. For the walls of one-story farm buildings, the most convenient method of lifting the concrete is by bucket or wheelbarrow. The latter method should be used if the work is very extensive, but for small jobs, buckets may suffice. Runways must be constructed strongly, with easy grades. Avoid sharp turns, and make runs at least 20 inches wide where above the ground, always lapping the right way. Where considerable work is being done, at least two wheelbarrows should be provided, so that the concrete may be placed as rapidly as possible. Wheelbarrows with metal bodies are handier and more durable than the wooden ones. Wheelbarrows must be watertight, as water allowed to escape from the mass carries cement with it.

The arrangement of scaffolding and runways must depend to a certain extent upon the methods of mixing used. Where the work is done by hand the mixing board may be moved around and kept conveniently close to the spot where the concrete is being used; if a mechanical mixer be employed, a good central location must be selected, and runways laid out so as to provide easy access to the mixer from all parts of the work.

Preparation of Forms. Form boards which have been used before must have all concrete well cleaned from faces and edges. By painting the faces with whitewash, crude oil or a mixture of equal parts of linseed oil and kerosene, the concrete is prevented from sticking and the forms are protected. It is important that forms for window and door openings be prepared properly to prevent sticking. Attention to this matter will save much labor and breakage in removing the forms, and is especially important where the forms are to be used several times. If the boards in the face of the forms contain knot holes, these must be covered on the outside with a board, and patched up with sticky clay or other similar material just before the forms are filled. The clay must be applied from the inside, and trowelled to give a smooth surface. Knot holes are sometimes covered with small pieces of tin tacked on the inside face of the boards, but where this is done the imprint of the tin patch is left in the wall.

Forms must be as nearly watertight as possible. Where the water is allowed to escape from the mixture, it invariably carries with it a considerable quantity of cement. Cracks between the boards often leave room for the mortar to squeeze through, producing fins or unsightly lines on the face of the wall. Sharp corners are hard to fill and are easily broken after the removal of the forms; therefore, they should be

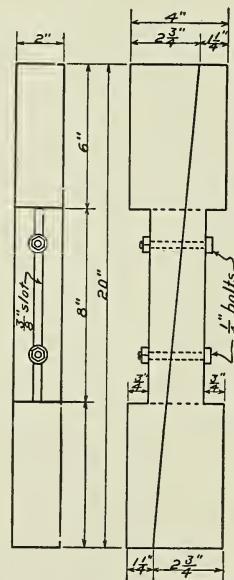


Figure 30. Adjustable Spacing Block used to keep forms for inner and outer walls at proper distance apart and to facilitate removal of the inner forms, double monolithic construction.

avoided by the use of fillets. Where the forms are held at proper distance by wires, these should be amply strong, as the breaking of a wire will allow the wall to bulge at that point.

Joining Old Work. The ideal way of constructing monolithic concrete walls is by one continuous operation, but in most cases this is impossible. Whenever concreting is interrupted, even for an hour, a weakened bond will occur between the new concrete and that previously placed unless special precautions are taken. Without these precautions, clearly defined joints or cracks are apt to develop. Frequently the work can be divided into sections that can be completed without interruption, thus avoiding horizontal joints and creating vertical ones where they will not weaken the structure nor detract from its appearance. To accomplish this, the forms should be erected in sections, or a board should be set up in the form, making a complete partition. So that the sections

of the wall will be keyed into each other, a groove should be formed in both ends of the first section, and thereafter in one end of each section. Such a groove can be made as shown in Figure 31, by placing a 2×4 vertically against the wall or partition in the form. Previous to placing, the edges of the 2×4 should be dressed so as to make it possible to remove it without destroying or marring the groove. In the course of construction, the next section will be concreted against the first and the groove will be filled with concrete, thus keying the two sections together.

In building up a wall the concrete in the section under construction should be kept at the same level as far as possible. If for any reason, fresh concrete is to be placed on concrete even partially

hardened, the surface to be built upon should be thoroughly drenched and then covered with a grout made by mixing cement with water to the consistency of cream, immediately before concreting is resumed. Concreting should be resumed immediately after the grout is applied and before it shows any signs of drying. The amount of water that will be required in dampening the old concrete will depend upon a number of conditions, but its tendency to absorb water must be satisfied; otherwise the water will be absorbed from the grout which will make it worthless, and defeat the object of its use.

All foreign matter, such as loose sand, straw, chaff, leaves, etc., must be removed from hardened or partially hardened concrete before work is resumed.

Removing the Forms. Haste in removing forms from the work often leaves the wall without proper protection from the weather, as well as from loads or stresses to which the walls may be subjected. In cold weather concrete hardens slower than in warm weather. It is impossible to lay down a definite rule for the removal of forms and other conditions from concrete work. In general, it may be stated that forms can be removed from concrete walls provided they are not to be loaded immediately, as soon as they obtain sufficient strength to retain their

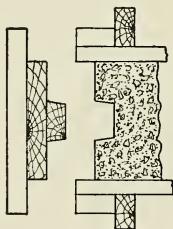


Figure 31. Method of joining foundation walls where it is necessary to leave an expansion joint or where concreting has been discontinued for any reason.

shape and permit of continuing the work without damage to the concrete in place. The saving of a small amount of time does not compensate for the risk of removing the forms too soon. Do not mistake a frozen wall for one in which the concrete has hardened. In removing or taking down the forms care must be taken not to damage the work. The forms should be well oiled or whitewashed as previously suggested so that the smallest possible amount of prying and bar work will be necessary. After removing forms held together by wires, as shown in Figure 27, the ends of the wire may be cut off flush with the surface of the wall, or if some finish is to be applied, the wires should be broken off an inch below the surface to prevent discoloration of the wall from rust.

Surface Finish. If the forms are built of smooth, dressed lumber, carefully manipulated so as to avoid marring and the concrete be placed wet enough to be quaky, and is then well spaded, the walls should require no further treatment. If a stucco finish is desired it may be secured as directed on page 52, in the chapter on "Cement Plaster Walls." It is not generally advisable to paint the surface of walls with cement and water grout for this often scales off.

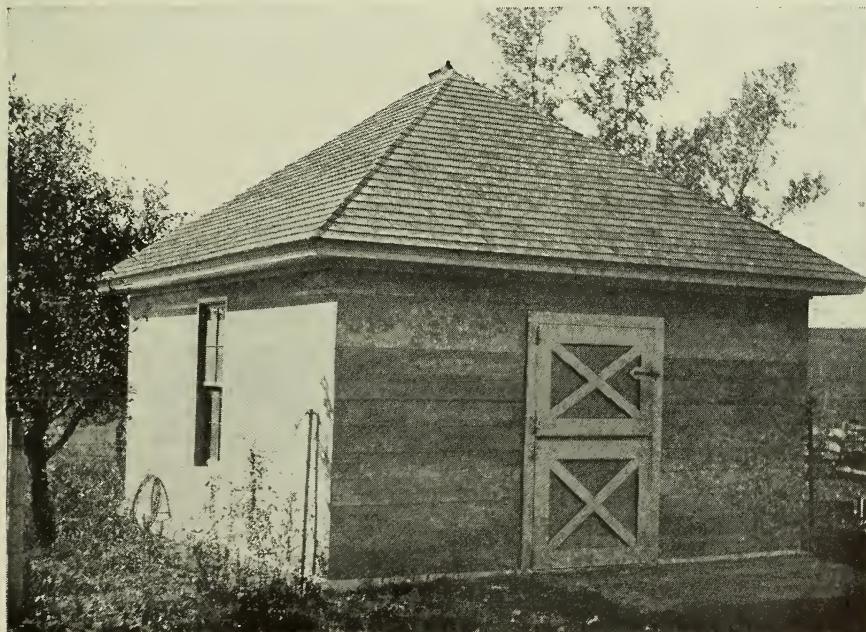


Figure 32. Monolithic Blacksmith Shop, Echo Valley Farm, Odebolt, Iowa. A convenient building equipped to take care of horse shoeing, wagon and implement repairs, and other forge and machine work required about the farm. Dimensions, 16 feet by 18 feet. Built by the owner, 1908.

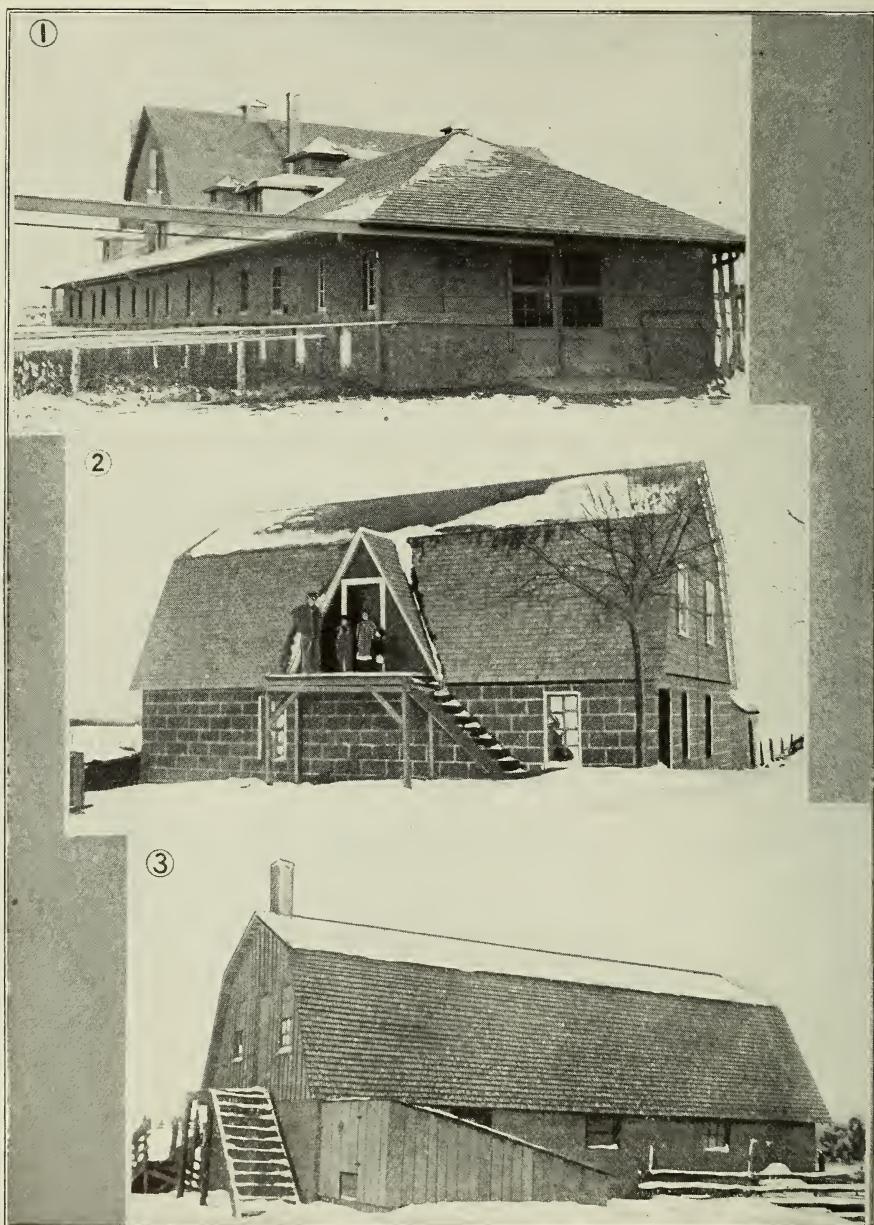


Figure 33. CONCRETE HOG HOUSES.

- (1) Col. J. Watson French's Hog House, Davenport, Iowa. Combination concrete and tile.
- (2) Concrete Block Hog and Chicken House of Fred Kolbert, Harbor Beach, Michigan.
- (3) Hog House of John Hunt, Bad Axe, Michigan. Type of concrete farm building common in Northern Michigan.

Wall Reinforcing

WALL reinforcing for small buildings, although a comparatively simple matter, is one which should receive careful attention. The functions of reinforcing metal in such walls are (1) to prevent cracks due to settlement and (2) to prevent cracks due to expansion and contraction from heat and cold. In low structures such as those discussed in this volume, the live load imposed upon the walls is seldom, if ever, great enough to require reinforcing and the wind load need not be considered.

It will generally be found satisfactory to reinforce the walls of one story buildings with a net work of vertical and horizontal rods placed in the centre of the wall. In double wall work each of the walls must be reinforced independently just as though the two walls were entirely separate. The reinforcing rods may be round, square, twisted square, or of special section so long as they have a sufficient effective cross-sectional area. In addition to the rods placed in the body of the wall, special reinforcing is required around all window and other openings and at all corners as described in later photographs. "Triangle Mesh" and similar reinforcing fabrics are sometimes substituted for reinforcing rods and there is no objection to their use if fabric used has a cross section at least equal to that of the reinforcing rods which would occupy the same area.

Such material as barbed wire, worn out fencing, and scrap iron must be avoided if the builder would feel sure of satisfactory work. The object of reinforcing is to secure strength, and for such a purpose, weak or badly rusted steel is obviously unsuited. Reinforcing rods which



Figure 34. Concrete Granary, Morgan Farm, Beloit, Wisconsin. This granary has a double row of wide bins, with a wide driveway up the middle. The floor and walls are of concrete.

have become rusty enough to scale must be cleaned off before placing in the wall, as the scale prevents the concrete from obtaining a firm grip on the metal. For removing scale, a stiff wire brush will be found well suited.

Size and Spacing of Rods. The following sizes and spacing of reinforcing rods is recommended: For walls less than 8 inches in thickness, use $\frac{3}{8}$ inch round rods, spaced 24 inches apart, center to center, both vertically and horizontally. For walls 8 inches to 10 inches in thickness, use $\frac{1}{2}$ -inch round rods spaced 24 inches apart, center to center, both vertically and horizontally. For walls wider than 10 inches, two systems of $\frac{3}{8}$ inch reinforcing rods near the inside and outside of the wall should be substituted for the one system at the center. Where two systems are required, the rods should be placed about 1 inch in from the inner and outer faces of the wall.

Rods should be wired together rigidly at all intersections, and the ends of the rods lapped a distance to equal 64 times the diameter of the rod, which, in the case of $\frac{3}{8}$ inch rod, is 24 inches and for $\frac{1}{2}$ inch rod is 32 inches. The reinforcing network should not be broken at any point, except for doors, windows, or other openings. To start the reinforcing, the vertical rods should be imbedded 18 inches to two feet in the foundation. The lowest horizontal rod should then be wired to the vertical rods, all around the building, at the ground level. Additional lengths of vertical rods are wired on as required, and the remaining bands of horizontal reinforcing placed as the work progresses.

Corner Reinforcing. All corners and openings require special methods of reinforcing. A simple and effective scheme for reinforcing corners is shown in Figure 36. Instead of being bent at the corners,

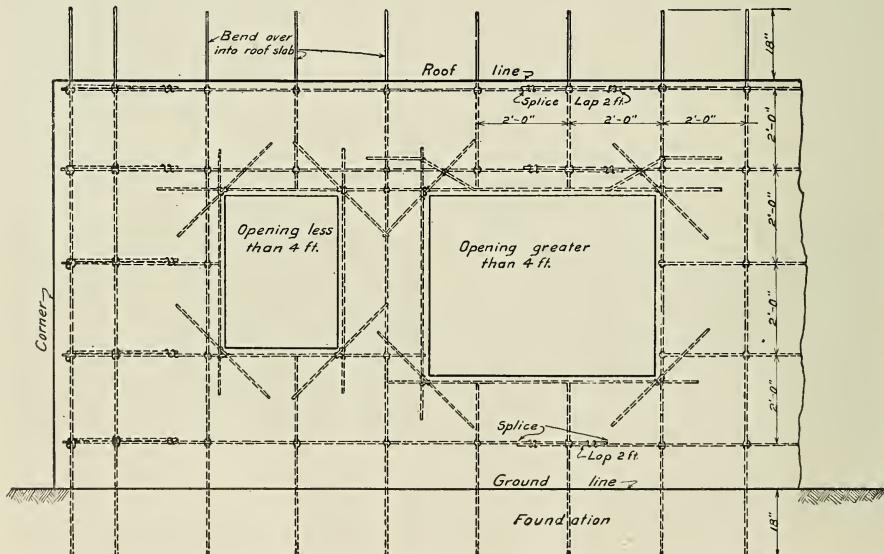


Figure 35. Diagram showing the general scheme for reinforcing monolithic walls for small buildings limited to one story in height.

which is a rather difficult job for long bars, the horizontal reinforcing rods are terminated and securely wired to a vertical rod at this point. Additional rods about 58 inches in length, bent to a right angle with equal legs, are used to reinforce the corner horizontally. These rods should be bent on a 6-inch radius, making the straight section of each leg about 24 inches long, the length required for good lap with the horizontal reinforcing, to which the corner reinforcing should be wired. For the corner reinforcing, $\frac{3}{8}$ -inch round rod or its equivalent in cross-sectional area, should be used.

Window and Door Openings. For all openings less than 4 feet in width, the system of reinforcing shown in Figure 37 is recommended. $\frac{3}{8}$ -inch round rods are used. Two rods are placed vertically on each side of the opening, two rods are placed horizontally below the opening, and three rods above the opening. Two rods are also placed diagonally across all corners of the opening as shown in the figure. Reinforcing rods placed above openings should be 3 feet longer than the width of the opening, while those on each side of, and below openings, should be at least 18 inches to 2 feet longer than the dimension of the opening in the direction parallel to the rods. Diagonal rods should be 2 feet to 3 feet in length.

Where door or window openings are more than 4 feet in width, it is advisable to modify the above scheme by bending up the ends of two of the rods above the opening as shown in Figure 38. This serves to take care of the large shear load which might otherwise unduly stress the concrete near the ends of the span. If the opening is 8 feet or more in width, the wall above should be strengthened still further by substituting $\frac{1}{2}$ -inch rods for the $\frac{3}{8}$ -inch rods recommended for smaller spans.

Calculating the Amount of Rods Required. It is a simple matter to figure out, fairly accurately, the amount of reinforcing rods required for the walls of any simple farm building. The number of rods needed for the vertical reinforcing equals one-half the perimeter of the building in feet, and for the horizontal reinforcing, one-half the height of the wall in feet multiplied by the number of rods in each course of horizontal reinforcing. Four corners require about 10 feet of extra rod per foot in height. The extra reinforcing metal around the windows and doors varies, of course, with the size of the opening. Reinforcing rod is sold by the pound, and generally comes in stock lengths from 12 feet to 30 feet. The area, weight per foot, and number of feet per pound of the commoner sizes of square and round reinforcing rods are given in the following table:

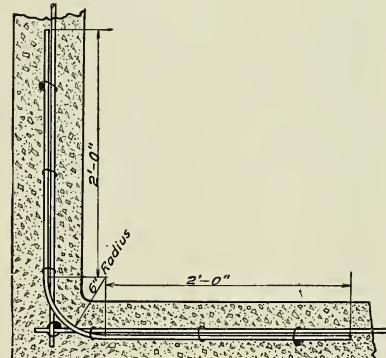


Figure 36. Method of reinforcing corner of monolithic buildings.

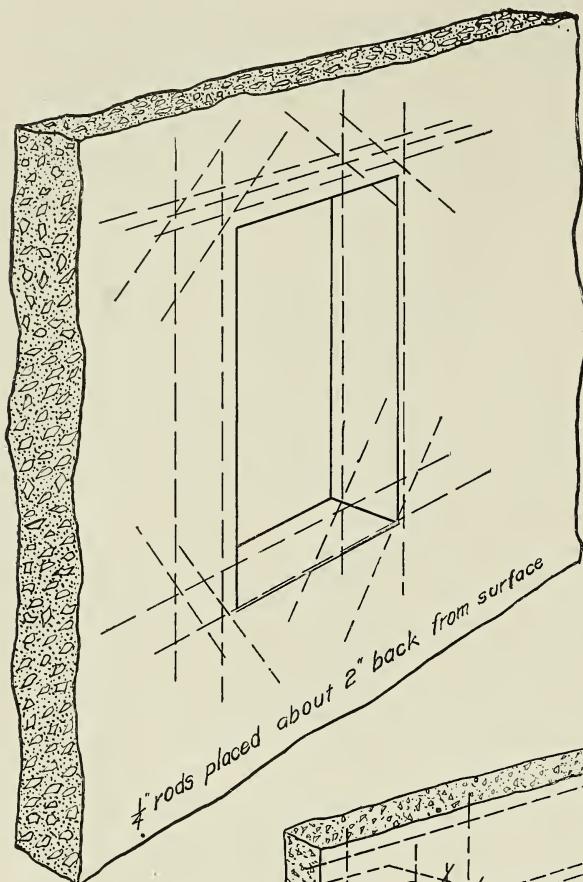


Figure 37. Method of placing reinforcing rods around wall openings less than 4 feet in width.

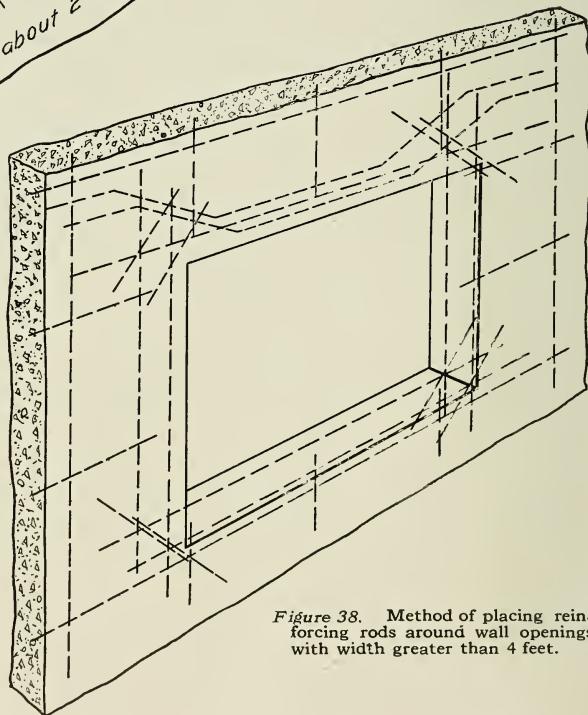


Figure 38. Method of placing reinforcing rods around wall openings with width greater than 4 feet.

Table B

Size	Area Square Rod	Weight of Square Rod 1 Ft. Long	Length of 1 Lb. of Square Rod	Area of Round Rod	Weight of Round Rod 1 Ft. Long	Length of 1 Lb. of Round Rod
$\frac{1}{4}$	.0625 Sq. In.	.212 Lbs.	4.720 Ft.	.0491 Sq. In.	.167 Lbs.	6.000 Ft.
$\frac{5}{16}$	.0977 Sq. In.	.333 Lbs.	3.000 Ft.	.0767 Sq. In.	.261 Lbs.	3.830 Ft.
$\frac{3}{8}$	.1406 Sq. In.	.478 Lbs.	2.090 Ft.	.1104 Sq. In.	.375 Lbs.	2.665 Ft.
$\frac{7}{16}$	.1914 Sq. In.	.651 Lbs.	1.530 Ft.	.1503 Sq. In.	.511 Lbs.	1.957 Ft.
$\frac{1}{2}$	.2500 Sq. In.	.850 Lbs.	1.175 Ft.	.1963 Sq. In.	.667 Lbs.	1.500 Ft.
$\frac{9}{16}$	.3164 Sq. In.	1.076 Lbs.	.930 Ft.	.2485 Sq. In.	.845 Lbs.	1.182 Ft.
$\frac{5}{8}$	.3906 Sq. In.	1.328 Lbs.	.752 Ft.	.3068 Sq. In.	1.043 Lbs.	.958 Ft.
$\frac{3}{4}$	.5625 Sq. In.	1.913 Lbs.	.523 Ft.	.4418 Sq. In.	1.502 Lbs.	.665 Ft.
$\frac{7}{8}$	.7656 Sq. In.	2.603 Lbs.	.384 Ft.	.6013 Sq. In.	2.044 Lbs.	.489 Ft.
1	1.0000 Sq. In.	3.400 Lbs.	.294 Ft.	.7834 Sq. In.	2.670 Lbs.	.375 Ft.

Table C

TABLE OF AREAS OF ROUND REINFORCING RODS AND WIRE

Diameter in Inches	A. S & W. Gauge	Diameter in Decimals of an inch	Area in Square Inches of Round Rod or Wire	Area in Square Inches of Square Rods
1	...	1.000	.785	1.000
$\frac{7}{8}$	...	.875	.602	.766
$\frac{5}{8}$	...	.750	.442	.563
$\frac{3}{4}$	...	.625	.307	.391
$\frac{1}{2}$	...	.500	.196	.250
...	7/0	.490	.189	...
...	6/0	.460	.166	...
...	5/0	.437	.150	.191
...	4/0	.430	.145	...
...	3/0	.393	.121	...
...	2/0	.375	.110	.141
...	1	.362	.103	...
...	2	.331	.086	...
$\frac{1}{4}$	...	.312	.076	.098
$\frac{5}{16}$	...	.307	.074	...
...	3	.283	.063	...
...	4	.265	.054	...
...	5	.250	.049	.063
...	6	.244	.047	...
...	7	.225	.040	...
...	8	.207	.034	...
...	9	.192	.029	...
...	10	.187	.027	...
$\frac{1}{8}$	...	.177	.025	...
...	11	.162	.020	...
...	12	.148	.017	...
...	13	.135	.014	...
...	14	.125	.012	...
...	15	.120	.011	...
...	16	.105	.008	...

Cutting and Bending Rods. The simplest manner of cutting small reinforcing rods is by means of a cold cut or chisel on an anvil or heavy piece of steel. Rods are sometimes cut up with a hack saw, but this method is somewhat slower. After indenting the rod all around with a chisel or cutting in a small distance with a saw, the end of the rod may be placed in some convenient device for holding it, while the opposite end is bent back and forth until the fracture occurs. Where there are a large number of rods required, as is the case when several buildings are to be erected, it is sometimes economical to invest in large bench shears, thus materially reducing the time required to cut the rods.

Single bends or angles in moderate sized rods are simple to make and hardly require explanation. Where three or four bends must be made some difficulty may be encountered in getting them all in the desired plane and at proper angle. The proper angles can generally be obtained quite easily by first marking off the desired shape of the rods on a board floor or top of a heavy bench and then nailing on substantial cleats in such a manner that the rods, when bent up between these cleats, will have the required angles. To prevent the rods from bending out of plane, clamps may also be required. In cases where there are a considerable number of rods to be bent, it may be economical to have the work done by a local blacksmith or secure a small bending machine, obtainable at moderate expense.

Walls Without Reinforcing. Short walls of excessive width and limited height are very often built without reinforcing. They are generally satisfactory for the first floor of low barns and similar work. Walls constructed without reinforcing should not be less than 12 inches in width. The height should be limited to 12 feet, and the length of each section of the wall should be limited to 30 feet. An expansion joint must be left between each section, as explained on page 36.



Figure 39. Iowana Farm, Davenport, Iowa, Col. J. Watson French, proprietor. The silos are of monolithic concrete. All of the buildings on the place are built of a combination of concrete and tile. Tri-City Construction Company, Davenport, Contractors.

Concrete Block Walls

CONCRETE block walls have found general favor because of their pleasing appearance, economy in construction, and also for the reason that the blocks may be made at odd times. Walls of this type can be made in a variety of face designs without the use of forms. Hollow block walls of a given size require but two-thirds the amount of material necessary for solid walls of the same dimensions, and the air spaces in hollow blocks interrupt the passage of heat and cold.

Concrete Blocks. For the sake of uniformity in appearance, blocks for a given piece of work should be made with the same materials, proportions, and amount of water. The blocks should also be cured under the same conditions. These precautions are necessary to insure uniform quality and color. The plain faces, either tooled or panelled, or broken ashlar designs are recommended in preference to the more common rock face which often presents an artificial appearance.

In the design of concrete block buildings the dimensions of the blocks available should be taken into consideration, and the plans so made that the walls may be built as nearly complete as possible with whole and half blocks, avoiding fractional sizes.

Concrete Sills and Lintels.

Concrete sills and caps may conveniently be used in walls made of any material, as these are easy and inexpensive to make in any desired size. Most block dealers carry such sills and caps in stock or have equipment for making them. If they cannot be purchased they can be molded in simple wooden forms similar to that shown in Figure 40. This form will make sills of any length, casting them face down. Proper slope is given to the top of the sill by tapered board (a). The pallet and sides of the mold should be dressed, covered with varnish or shellac, so as to give the sill a smooth surface, free from marks showing the grain of the lumber. By removing this, the form is made suitable for casting lintels or caps. A mixture of 1 part cement to $2\frac{1}{2}$ parts coarse sand, to 2 parts small stone aggregate, will be found satisfactory, enough water being used to make the mass quaky. A $1:2\frac{1}{2}$ cement and sand mixture should be used to surface the work. About one inch of this facing should be put down first, and pockets and uneven patches avoided by working the facing well up to all surfaces. The mold should then be filled up with the $1:2\frac{1}{2}:2$ concrete, and tapped with a hammer or jarred to compact the mass and force out the air.

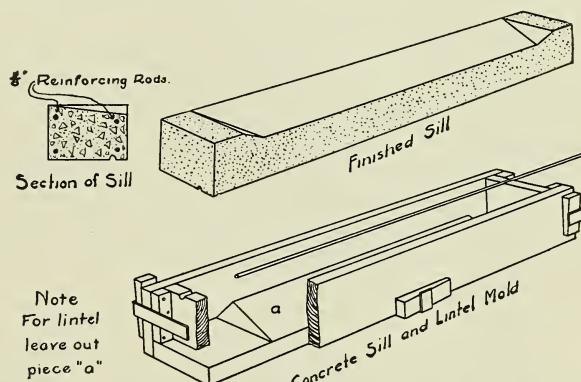


Figure 40. Mold Box for Casting Sills and Lintels, face down, and Finished Sill.

The bottom of the sill may be smoothed off with a wooden straight edge. The width of sill must be about $1\frac{1}{2}$ inches greater than the thickness of the wall. Form marks and other irregularities can be removed by rubbing with a concrete brick made of one part cement to two parts sand.

Laying Concrete Block Walls. The rules for laying block walls are simple. The "knack" of doing neat and rapid work is not hard to acquire. The equipment necessary consists of a mortar mixing box, 3 feet by 5 feet, mortar board 30 inches by 30 inches made of 1-inch lumber, planed on one side and both edges and held together by two or three cleats; also a trowel, hand level, straight edge and plumb board. All blocks must be drenched with water before being used or the moisture will be drawn from the mortar. The first course of block should be laid upon a mortar joint fluctuating in thickness so that regardless of any irregularities in the blocks the course will be absolutely level. The blocks, which have previously been drenched, are laid in a quarter-inch bed of cement mortar. A quarter-inch mortar joint is also placed between the ends of abutting blocks. Each course is begun at the corners and laid toward the middle of the wall. The blocks should be laid level and kept in perfect alignment. Good alignment is maintained by working strictly to a line, stretched over the outer edge of the wall on the same level with the top of the blocks being laid. The wall should be tested frequently by placing the plumb level against it to see that it is perpendicular.

If a concrete roof is to be placed on a concrete block building, the top course of blocks must either be cast without air spaces, or the air



Figure 41. Monolithic Milk House and Tank, Funk Farms, Shirley, Illinois. Mr. Funk also has a concrete hog house and several concrete silos.

spaces must be filled up with concrete before the blocks are laid. If the latter method is used, the blocks may conveniently be laid down on a concrete or other flat surface with the air spaces in a vertical position, and the latter filled with slush concrete. If it is desired to build a concrete roof upon a concrete block building which has been up for some time, it may be found convenient to lay small sections of sheet iron or similar material over the air spaces in the blocks to prevent the concrete from running through.

Good cement mortar is made in proportions of 1 part cement and 2 parts sand mixed with enough water to make it of the required consistency. Regardless of the care taken in the preparation of the mortar, it will be practically destroyed by being robbed of its moisture, unless the blocks are damp when placed. Cement mortar starts to harden very soon, and for this reason only such quantities as will be used within half an hour should be mixed.

Table D

NUMBER OF STANDARD SIZE CONCRETE BLOCK NECESSARY PER
LINEAR FOOT OF WALL

Height of Wall	Number of Blocks per Linear Ft.	Height of Wall	Number of Blocks per Linear Ft.	Height of Wall	Number of Blocks per Linear Ft.
2 ft.....	2.25	6 ft.....	6.75	9 ft. 4 in.....	10.50
2 ft. 8 in.....	3.00	6 ft. 8 in.....	7.50	10 ft.....	11.25
3 ft. 4 in.....	3.75	7 ft. 4 in.....	8.25	10 ft. 8 in.....	12.00
4 ft.....	4.50	8 ft.....	9.00	11 ft. 4 in.....	12.75
4 ft. 8 in.....	5.25	8 ft. 8 in.....	9.75	12 ft.....	13.50
5 ft. 4 in.....	6.00				

NOTE—These blocks are $7\frac{3}{4}$ inches high, by $15\frac{3}{4}$ inches long, by 8 inches in width, which makes them 8 inches high, 16 inches long and 8 inches in width in the wall. This allows for a quarter inch of mortar around each block.

Unit Column and Slab Walls

Method of Construction. In slab or panel wall construction, the individual wall sections and the posts or columns are cast separately on the ground and when properly hardened, are assembled so as to form a complete wall. This construction is well suited to low buildings such as cattle and implement sheds, poultry houses, piggeries, etc. The slabs are held in place by columns or posts recessed to receive them as illustrated by Figure 42. These recesses are formed by attaching to the sides of the mold, strips of wood, the dimensions of which are the same as those of the recesses required. Slabs may be made to weigh as much as 600 pounds, although they are more conveniently handled

if made lighter. The weight of a slab 2 inches thick 2 feet wide and 8 feet long is 400 pounds. Although the thickness may vary somewhat, the length should not be over 8 feet. Two feet is a convenient width, but with a short length a greater width may be used.

Columns are required on each side of door or window openings to hold the slabs in line; however, with small windows, where the depth is not greater than the width of one slab, a wooden window frame is sufficient. Where possible, it is well to place the opening next to columns, for by this arrangement only one extra column is necessary for long openings; and for small windows the end of only one slab need be held in line by the window frame.

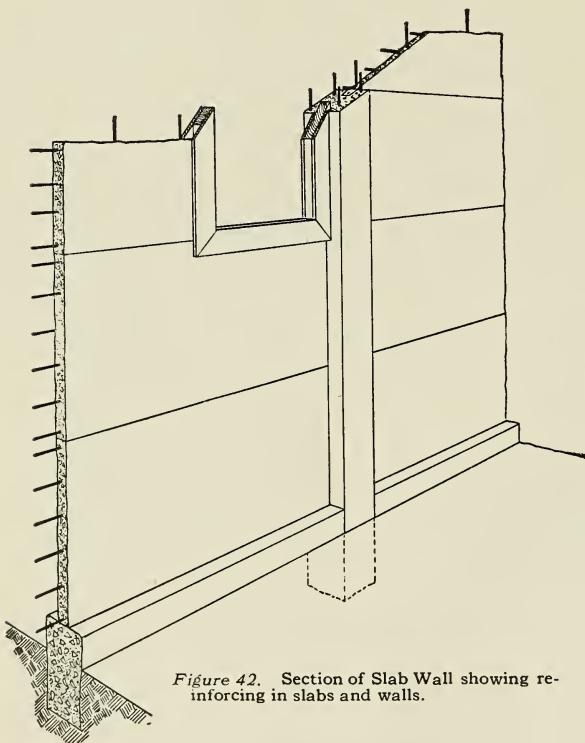


Figure 42. Section of Slab Wall showing reinforcing in slabs and walls.

The Columns. The general shape of the column mold is illustrated by Figure 107 page 122. Molds should be made of 2-inch material and well braced at the center to prevent bulging. Pallets are not necessary for the line column molds, as the cores are placed on the two opposite sides. The corner columns must be made on a pallet as they are recessed on two adjacent sides, the cores for one recess being fastened

to the pallet, while the other is fastened to one side of the mold. The cores should be beveled one-eighth of an inch on each side, so that they can be drawn from the columns without injury to them. Where slabs 2 inches in thickness are used, line columns should be 7 inches square. Columns having two adjacent sides recessed should be 8 inches square, however, in order to give ample section of concrete between recesses. Care should be taken that the recesses in the heavier columns are placed the same distance from the exterior surface as those in the lighter columns.

The reinforcing consists of four $\frac{3}{4}$ inch rods, held together with soft iron wire ties spaced about 12 inches apart along the reinforcement. Concrete for the columns is mixed in the proportion of 1 part cement, to $2\frac{1}{2}$ parts clean, coarse sand, to 3 parts screened gravel not to exceed $\frac{3}{4}$ inch in size. The reinforcing rods in two corners diagonally opposite should be allowed to project about 3 inches from one end of the column; this may be accomplished by boring holes in the end of the molds and allowing the rods to project through. When the columns are set up, these rods will be grouted into holes drilled in the floor or foundation wall.

Concrete posts set 40 inches in the ground may be used instead of columns. These posts should be of the same cross section and recessed in the same way as the columns, excepting that they are 40 inches longer to provide for placing in the ground. For this construction a concrete curb of the same width as the posts should be placed between them to furnish proper support for the slabs. The curb must be built on firm soil, being about 18 inches in height, and extending not over 6 inches above ground.

The Panels or Slabs. Forms for the slabs are made of lumber 4 inches wide and of the same thickness as the slabs. The side pieces are cut two feet longer than the length of the required slab to provide for cleats to hold the end pieces, which are cut to the same length as the width of the slab. The sides are wired together with No. 12 wires looped through $\frac{3}{8}$ -inch holes in the form and held by placing nails in the loops,

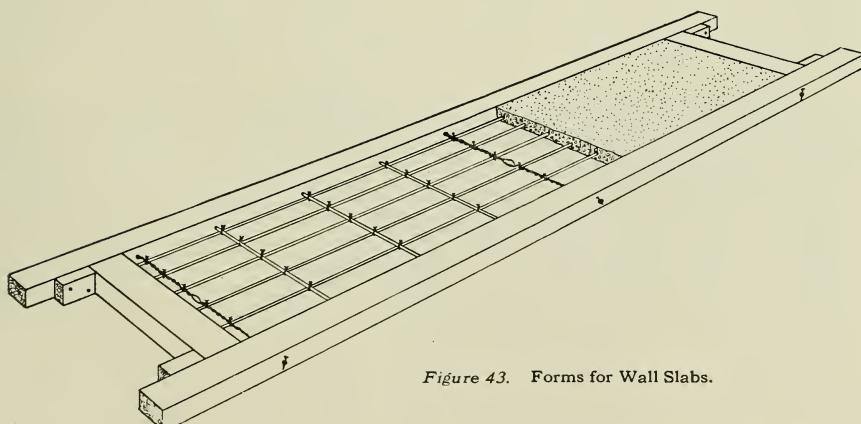


Figure 43. Forms for Wall Slabs.

as shown in Figure 43. Where slabs have a length of from 6 to 8 feet a tie wire is placed 2 inches from each end and one midway between.

The wires serve not only as ties, but also as the cross reinforcing at these points. The end ties are twisted until the sides are drawn tight against the end pieces and the middle then drawn as tight as possible without distorting the sides from a straight line. With shorter slabs, two tie wires will probably answer. These should be located so as to replace two of the reinforcing rods, and at the same time properly secure the form. After the tie wires have been twisted sufficiently tight, the long reinforcing rods are placed and wired to them with soft iron wire as shown in Figure 43. The form is then turned over and the cross rods are wired to the long ones. It is well to wire the reinforcing in a number of forms before starting to place the concrete, thus necessitating no interruption in the latter part of the work.

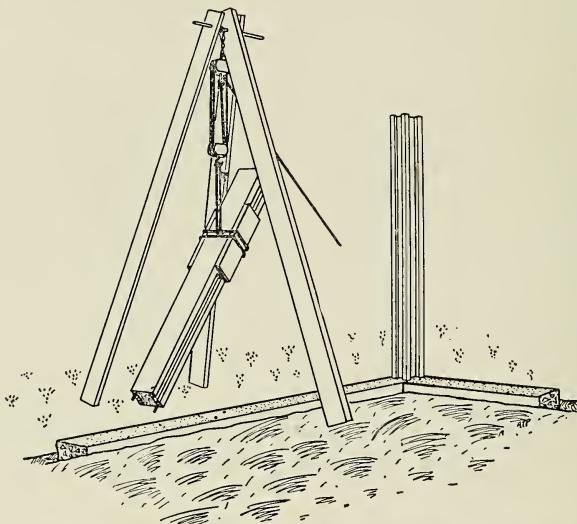


Figure 44. Tripod, Block and Tackle for lifting and placing columns and slabs.

With a smooth floor or platform available, the wall slabs may be cast directly upon it, or if the structure is to have a concrete floor this should be built first and when properly hardened will afford a convenient place for the making of slabs. In order to economize in floor space the slabs may be cast with a layer of paper to prevent the slabs from adhering to the floor or to each other.

For any size slab, up to 2 feet by 8 feet, the reinforcing should consist of $\frac{1}{4}$ -inch round or square steel rods free from rust. Reinforcing rods must be placed one inch from each edge, the remaining horizontal rods being spaced about four inches apart, and the vertical rods twelve inches apart or less. The more closely spaced reinforcing must always be placed horizontally, and wider spaced reinforcing vertically, no matter whether the length of the slab extends in a horizontal or a vertical

direction. Thus, a slab made to be used in a horizontal position in the wall is not properly reinforced for use in a vertical position; the opposite is equally true.

The mixture used should be made of 1 part cement, $2\frac{1}{2}$ parts clean, coarse sand and 2 parts gravel—the latter not to exceed one-half inch in size. If no gravel is used the proportion of sand may be increased to three parts. Enough water must be used to give a quaky consistency. Cement mortar is placed between the slabs and also in the recesses between columns and slabs, thus making a weather-tight wall. Before filling in these joints, the edges of the slabs and columns should be soaked thoroughly and painted with a cement grout.

Tripod and Tackle. The work of placing the columns and slabs in position is greatly simplified by the use of a tripod with block and tackle, as shown in Figure 44. The tripod can conveniently be made of 2 x 6 inch or 2 x 8 inch plank held together at the top by a large bolt or rod from which the block and tackle are suspended. In placing recessed columns or posts with the tackle it is advisable to protect the corners from injury by using wood between the concrete and the rope, as shown in the figure. No attempt should be made to place either columns or slabs until these are thoroughly cured, for the greatest strains on these members are carried while being placed in position.



Figure 45. Beach Farm Dairy, Coldwater, Michigan, Neal & Angevine, proprietors. Barns, silos, dairy house and other buildings are of monolithic concrete. The walls of all the structures except the silos are marked off in imitation of concrete blocks. The low building to the right is the dairy barn, which is ventilated by means of the two concrete stacks. R. C. Angevine, Coldwater, was the contractor.

Cement Plaster Walls

Method of Construction. Cement plaster construction offers one of the most convenient as well as economical methods of building concrete walls for small farm buildings. The framework for the support of the plaster walls should be constructed on concrete columns and beams, cast in mold boxes similar to that shown in Figure 107, on page 122. For ordinary low farm buildings, columns and beams 8 inches square may be considered standard, being reinforced with one round reinforcing rod near each corner. In general, where the length of the columns or beams does not exceed 8 feet, columns may be reinforced with four $\frac{3}{8}$ -inch round rods, and beams with four $\frac{1}{2}$ -inch round rods. Rods of shapes other than round may be used if equivalent in size, that is equal in cross sectional area.

A good method of securing the columns to the foundation or floor is described on page 49. Two reinforcing rods diagonally opposite should be allowed to extend 3 inches from the end of the columns, which is to be placed on the foundation as suggested under "Unit Slab and Panel Walls." A suitable method of joining columns and beams is shown in Figure 46. A $1\frac{1}{2}$ -inch round rod twelve inches long should be placed in the center of the top end of each column, being allowed to protrude up 6 or 7 inches. The purpose of these rods is to form pins by which the beams are secured to the columns.

All beams may be cast in the same mold box as the columns, small end cores being inserted to form the recesses in both ends of the beams as indicated in the illustration. Special attention should be given to joining the beams at the corners, and for this purpose the shaping as shown, of the ends of all beams at the corners, will be found convenient. No. 12 galvanized wires should be embedded in the outer face of the columns and beams at intervals of 10 to 12 inches, these being required

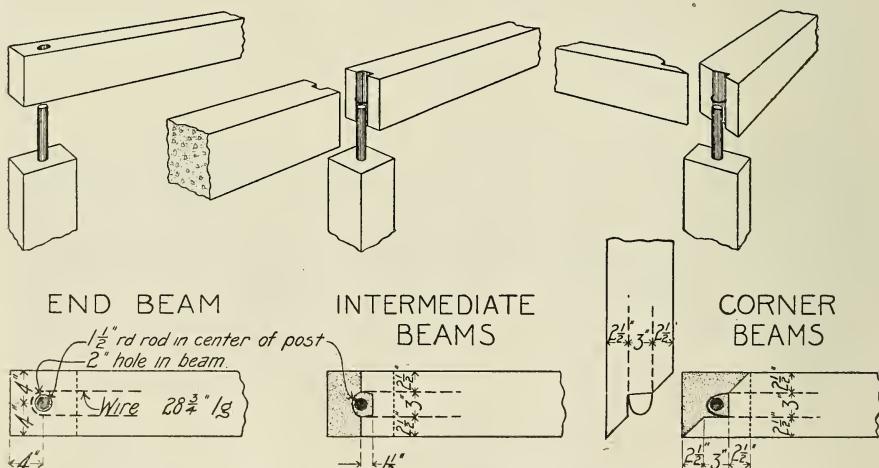


Figure 46. Method of joining end beam, intermediate beams and corner beams to column.

to hold the wire lath in place. After the beams are in place, the spaces at the joints should be filled with mortar, wet enough to flow readily to all parts of the joint, filling every crevice.

Metal Lath. Several types of metallic lath are obtainable. One type, made from slotted metal, is formed into a variety of shapes with different size openings and can be obtained in various weights; the lath is usually coated temporarily to protect the metal from rusting. This type of lath provides a good support for the first plaster coat because of the rough or uneven surfaces which catch and hold the plaster, but the cut edges of the metal have a tendency to rust where there is any dampness, unless the lath is thoroughly covered with plaster on both sides.

Another type, known as wire lath, is made from drawn wire, woven to form a network of fabric having $2\frac{1}{2}$ meshes per inch. The lath is obtainable japanned or galvanized and with various sizes of wire; the best lath is one that has been galvanized after weaving, as the coating is thus more serviceable besides adding to the stiffness of the lath. While wire lath does not provide as good a support for the first plaster coat as slotted metal lath, the drawn surfaces show less tendency toward rusting. For straight walls, lath made from No. 18 wire is recommended, but for shaping cornices, etc., it is better to use the lighter wire (No. 21) as this can be bent more easily to the desired form.

Applying the Lath. Care should be taken to stretch wire lath well over the framework,

otherwise when applying the first plaster coat the lath will bend in places under the pressure of the trowel, thus interfering with the clinch of the plaster upon the mesh and giving the wall an uneven surface. Where metallic lath without stiffener is used, the columns should not be placed further apart than 4 feet; where it is desirable to place the columns at a greater distance apart, it is necessary that the lath be stiffened either by a system of vertical reinforcing rods or that lath with self-contained stiffeners be used. $\frac{1}{2}$ -inch reinforcing rods make suitable stiffeners when spaced 12 to 18 inches apart; extra



Figure 47. An Attractive Concrete Barn on the farm of John Lindholm, St. Charles, Illinois. Dimensions, 20 feet by 30 feet inside. Cost, \$600. This building contains a carriage and automobile room, stalls for one horse and three cows, a small granary, and a hay mow.

rods should be put in, however, around door and window openings, about 2 inches back from the surface. The lower ends of these rods may be grouted into holes drilled in the top of the foundation, while the top ends should be secured by the No. 12 wires placed in the beam. It is generally advisable to use one horizontal reinforcing rod as a tie for the vertical rods. The horizontal rod should be $\frac{1}{2}$ inch in diameter, placed 2 to 3 inches below the window openings. The horizontal rods must be wired to the vertical rods at each intersection.

Metal lath should be lapped at least one inch wherever joined, and fastened to the columns and stiffeners in such a manner as to preclude the possibility of sagging or bulging. For fastening metal lath to the stiffeners, No. 18 soft wire galvanized, is recommended, although No. 16 plain soft wire may be used instead. Wire lath is sold in rolls, and there are several advantages in running the lath in strips around the building, rather than putting on the length of the roll in a vertical direction. Expanded metal is generally sold in large sheets of various size, and may be cut up in such a manner as to make one sheet completely cover the space between two adjacent columns. It is generally advisable to put up a temporary wooden framing to hold the lath rigidly in position until the first plaster coat is applied.

Number and Thickness of Plaster Coats. Cement plaster is usually applied in three or more coats, designated as the first coat, the intermediate coat, and the finish coat. For best results no plaster coat should be more than half an inch thick, regardless of the thickness of the wall desired. In order to estimate the amount of cement and sand required in covering the walls with cement plaster, the following table has been prepared:

Table E

NUMBER OF SQUARE FEET OF WALL SURFACE COVERED PER SACK
OF CEMENT, FOR DIFFERENT PROPORTIONS AND VARYING
THICKNESS OF PLASTERING

Proportions of Mixture	MATERIALS			TOTAL THICKNESS OF PLASTER				
	Sacks Cement	Cu. Ft. Sand	Bushels Hair*	$\frac{1}{2}$ In.	$\frac{3}{4}$ In.	1 In.	$1\frac{1}{4}$ In.	$1\frac{1}{2}$ In.
				Sq. Ft. Covered	Sq. Ft. Covered	Sq. Ft. Covered	Sq. Ft. Covered	Sq. Ft. Covered
1:1	1	1	$\frac{1}{8}$	33.0	22.0	16.5	13.2	11.0
1:1 $\frac{1}{2}$	1	1 $\frac{1}{2}$	$\frac{1}{8}$	42.0	28.0	21.0	16.8	14.0
1:2	1	2	$\frac{1}{8}$	50.4	33.6	25.2	20.1	16.8
1:2 $\frac{1}{2}$	1	2 $\frac{1}{2}$	$\frac{1}{8}$	59.4	39.6	29.7	23.7	19.8
1:3	1	3	$\frac{1}{8}$	67.8	45.2	33.9	27.1	21.6

*Used in scratch coat only.

NOTE—These figures are based on average conditions and may vary 10% in either direction, according to the quality of the sand used.

No allowance is made for waste.

After deciding upon the total thickness of the wall and the mixture to be used, it is easy to determine the total materials required for covering a given wall surface, since the table shows the number of square feet of surface covered by the mortar produced from one sack of cement. The table does not consider the cement mortar likely to be lost through waste when plastering; part of this waste, however, can be prevented

by placing a plank on the ground at the base of the wall to catch the plaster that falls. Plaster should never be used after it has once begun to harden and therefore should not be allowed to accumulate, but should be gathered up promptly and remixed with the mortar already prepared. It may be well to state here that cement plaster should not be mixed in batches larger than are needed for immediate use, otherwise, some of the mortar may begin to harden before it can be used and must therefore be thrown away.

When the sand used for the mortar is practically dry, the cement may be mixed with the dry sand in one sack batches and portions of this mixed with water as required. When the materials cannot be handled in this way and the mortar must be mixed in batches requiring less than a sack of cement, the proper amount of cement should be measured by weight and not by bulk. If it is kept in mind that one sack of cement contains one cubic foot and weighs 94 pounds, it is easy to determine the weight of any desired fraction of a cubic foot.

Mixtures for

Mortar. For the first coat a mixture of 1 part cement to $1\frac{1}{2}$ parts clean, coarse, well graded sand is recommended to which $\frac{1}{8}$ bushel of hair or fibre is added per barrel of cement. The hair or fibre should be soaked thoroughly and well separated before using it in the mortar; the best results will be obtained if the proportion of hair or fibre is mixed thoroughly with the required amount of dry sand before adding the cement.

There is a tendency among plasterers to use lime in the first coat and sometimes in the other coats, but because of the danger of getting unslaked material into the mixture, the use of lime is to be discouraged. If lime is permitted it should be added in the proportions of one part lime putty to ten parts cement and sand mortar. At least two weeks before using it in the mortar, the lime should be slaked thoroughly; a day or two before beginning work the lime should be reduced to liquid form by the addition of water and should be strained through No. 16 sieve into a tight box to remove any unslaked particles. This mixture should then be allowed to settle and form a lime putty, the surplus water being drawn off or evaporated; the lime putty may be kept indefinitely if not allowed to become hard.



Figure 48. Concrete Block Well House of Mr. M. Sullivan, Marshall, Minnesota. Marshall Tile and Sidewalk Company, builders.

Applying the Plaster. The first coat should be of such a thickness as will cover the lath and fill the meshes, and as soon as sufficiently hardened it should be scratched at right angles and at 45 degrees to the horizontal with a scratcher to provide a surface for the next coat. The scratcher may be made as shown in Figure 49. It should not cut a sharp line in the plaster, but rather form grooves with ridges on the sides, thus making a rough surface to receive the next coat.

The second coat and all subsequent coats should be applied after the preceding coat has hardened, but preferably before it has had time to dry out. Each coat should be brought to a true plane and, excepting the finish coat, should be scratched in the same way as the first coat. Immediately before applying any coat, the preceding coat should be thoroughly drenched and then treated with a grout of neat cement mixed with water to the consistency of thick cream. This grout is applied with a calcimining brush and the plaster must be put on before the grout shows the least indication of drying. All intermediate coats should be mixed the same as the first coat, omitting the hair or fibre.

Pebble-Dash Finish. For the finish coat a mixture of 1 part cement and $2\frac{1}{2}$ parts coarse sand is recommended and this should be prepared and applied in the manner described for the previous coats. To obtain a rough cast or pebble dash finish the mixture above mentioned is dashed against the wall from the hand or from a paddle or a swab of tightly bound, pliable twigs, and adhering to the wall forms a rough, hard surface. Sometimes a part of the sand is replaced by an equal amount of small pebbles or limestone passing a $\frac{1}{4}$ inch screen and free from dust. The mixture is taken up in the hand or

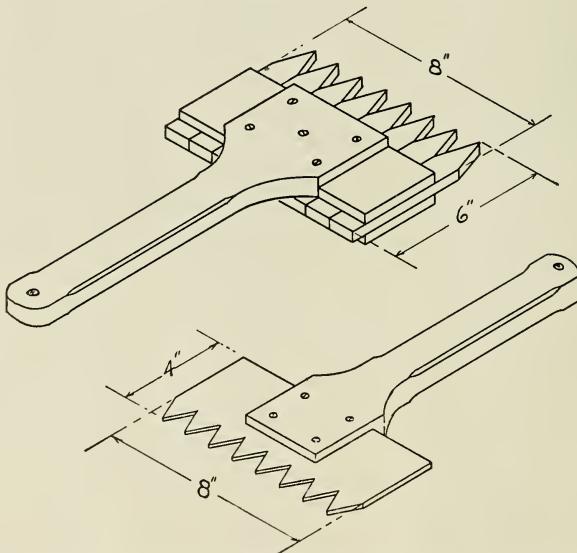


Figure 49. Two forms of simple and effective scratchers. The lower scratcher is made of an old saw-blade or scrap of tempered steel.

on the paddle or swab and thrown directly toward the wall; it should strike squarely, for if the mixture strikes the wall at an angle it will not adhere. After some practice, the material can evenly be distributed over the wall by this means. The texture of this finish will vary with the size of the material used in the mixture, and with the consistency, but in all cases the dust and fine particles should be removed from the aggregate. Before starting to apply a pebble-dash finish it is wise to experiment with small areas of surface made with various sized materials. This may be done in out-of-the-way places in the wall, and later covered, if necessary. In this manner an idea of the various texture is obtained, and an intelligent selection is made.

Precautionary Measures. In plastering buildings the work should be planned so that, if possible, an entire wall of the structure can be covered with plaster in one day; this will tend to produce uniformity in the texture and color. Great care should be taken to keep the materials, the proportions and consistency of the mixture, and the methods of application the same from day to day, for variation in one or all of these will produce a wall of mottled appearance. This is especially important for the finish coat, where it is highly desirable to produce a uniform color and surface. Should it become necessary to stop work before any coat has been applied to the entire surface, the treatment to obtain proper bond should not be ignored. No plastering should be done during freezing weather. In hot weather the plaster should be protected from sun or drying winds; otherwise cracking and checking from too rapid drying may result. Protection may be provided by hanging a cloth six inches or so away from the wall and keeping this damp until the paster has well hardened.



Figure 50. Concrete Block Corn Crib on the Farm of C. D. Babb, near Wagner, Illinois. Mr. Babb has two cribs of this type which have been in use for two years and are giving satisfaction.

Concrete Roofs for Farm Buildings

ON the average farm, with six to twelve buildings, the work of keeping the shingled roofs in repair frequently consumes much time and makes considerable expense, and at best some of the roofs are nearly always in a leaky condition.

Wooden roofs are short lived, need frequent repairs, often become warped and unsightly, and are liable to cause the destruction of the whole building by fire, even though other parts are built of practically non-combustible materials. The roof is the most vulnerable part of the building; it is exposed to sparks and embers from without, and if made of a combustible material, is easily set ablaze by fires from within, which quickly reach the roofs of small buildings. Steel roofs are

expensive in first cost and upkeep, requiring frequent painting to prevent rusting out. Such roofs are easily blown off by high winds, and readily twist out of shape or collapse under the heat of a fire.

Although several roofing materials are available, concrete makes the best roof for small concrete farm buildings. The first cost of a concrete roof is very often no greater than that of a wooden roof, and when freedom from repairs is considered, the con-

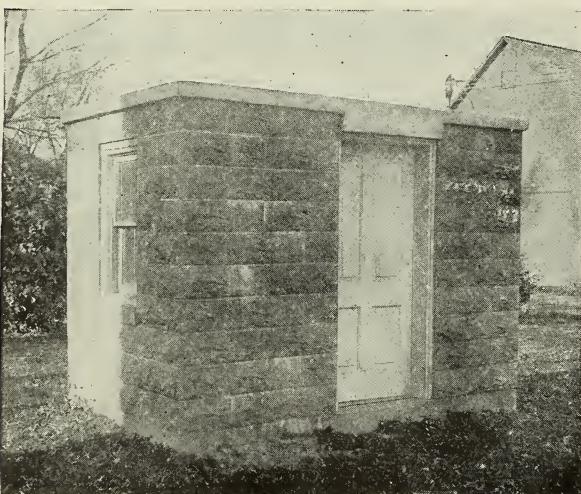


Figure 51. Concrete Block Well House with concrete roof. S. J. Forbes, Owner, Marshall, Minnesota. Built by the Marshall Tile and Sidewalk Company.

crete roof is undoubtedly the cheaper. The extra expense of putting a concrete roof on a concrete building is not great, as the concreting materials for the roof can be hauled at the same time as those for the walls, and the additional work of mixing and placing the concrete amounts to only a few hours labor, with materials and tools already on hand. The forms need only consist of a floor of dressed boards rigidly supported by a scaffolding.

The ordinary types of wooden, steel and slate roofs require a comparatively steep slope to make them proof against driving rains. In contrast with these, the concrete roof may be made very flat—often having only one-quarter of an inch of rise per foot. If desired, the under side of the roof may be made perfectly flat, and the slope obtained by varying the thickness of the slab. The comparatively flat roof makes

a saving in materials by reducing the roof area. Concrete gutters may easily be formed on the eaves of concrete roofs, adding a desirable feature to the roof without the disadvantage of iron gutters, which rust out after a few years of service.

Types of Roofs Suitable for Small Farm Buildings. Flat roofs are the most simple to construct. They meet all of the requirements of small farm buildings, and at the same time are capable of high architectural development and may be built with less concrete and more simple form work than concrete roofs of other types. Gable roofs are a little more difficult to build than flat roofs, but where desired, these may successfully be constructed. Roofs having four sides sloping from a ridge or center may be successfully constructed if especial care is taken to get sufficient reinforcing metal correctly placed at the ridges. Such roofs have a tendency to crack at the corners unless adequately reinforced.

For buildings where the roof span does not exceed 8 feet, the unit beam and slab roof described on page 123, in connection with the hog shelter house, may be used. Such roofs have very few, if any, advantages over monolithic roofs, however, except that they may be removed, should occasion require.

Cement asbestos shingles put on wooden framing have been quite widely used during the last few years, and these make good, durable roofs. Cement asbestos shingles resist fire from without, but because of the wood rafters and sheeting, they are not proof against fire from within.

Flat Slab Roofs. Table F shows the thickness of slab required for concrete roofs of various dimensions from 4 feet square up to 16 feet square, and Table G gives the amount of cement, sand and stone (screened gravel or limestone) required for roofs of various sizes and thicknesses. Table H shows the size and spacing of reinforcing rods. To

Table F
THICKNESS OF ROOF SLABS IN INCHES.

Width in Feet Between Center Lines of Walls	LENGTH OF ROOF IN FEET BETWEEN CENTER LINES OF WALLS						
	4 Ft.	6 Ft.	8 Ft.	10 Ft.	12 Ft.	14 Ft.	16 Ft.
4 Ft.....	2 In.	2 In.	2½ In.	2½ In.	2½ In.	2½ In.	2½ In.
6 Ft.....		2½ In.	2½ In.	2½ In.	3 In.	3 In.	3 In.
8 Ft.....			3 In.	3½ In.	3½ In.	3½ In.	4 In.
10 Ft.....				3½ In.	4 In.	4½ In.	4½ In.
12 Ft.....					4 In.	4½ In.	5 In.
14 Ft.....						5 In.	5½ In.
16 Ft.....							6 In.

Load = Weight of roof + 50 pounds per square foot.

find the thickness of slab, spacing of reinforcing rods, and amount of concreting materials and reinforcing metal necessary, proceed as in the example given at the bottom of this page.

TABLE G.
Cement, Sand and Stone

Required for Concrete Slab Roofs. Proportions for concrete 1:2½:4. Each cubic yard of 1:2½:4 concrete requires about 1.4 Bbls. of cement, .51 cubic yards of sand and .82 cubic yards of stone.

WIDTH OF SLAB IN FEET (BETWEEN EAVES)										
				4	6	8	10	12	14	16
Sacks of Cement (1 Sack=1 Cu. Ft.)		Length of Roof in feet between eaves		4	6	8	10	12	14	16
		4	.55							
		6	.82	1.54						
		8	1.39	2.06	3.29					
		10	1.71	2.57	4.79	6.00				
		12	2.06	3.70	5.76	8.20	9.84			
		14	2.40	4.32	6.72	10.80	12.92	16.8		
		16	2.74	4.92	8.76	12.32	16.44	21.12	26.32	
Cu. Ft. of Sand		Length of Roof in feet between eaves		4	1.35					
		6	2.03	3.78						
		8	3.44	5.08	8.1					
		10	4.25	6.35	11.9	14.85				
		12	5.08	9.19	14.25	20.4	24.6			
		14	5.94	10.7	16.65	26.8	31.8	41.6		
		16	6.77	12.2	21.75	30.6	40.74	52.2	65.2	
Cu. Ft. of Stone		Length of Roof in feet between eaves		4	2.18					
		6	3.26	6.14						
		8	5.54	8.18	13.1					
		10	6.80	10.20	19.1	23.9				
		12	8.18	14.75	22.9	32.7	39.2			
		14	9.58	17.2	26.8	43.0	51.5	67.0		
		16	10.90	19.7	34.9	49.2	65.8	84.1	104.75	

Example. Required, the thickness of slab, amount of concreting materials, spacing of lateral and transverse reinforcement, and the amount of reinforcing rods, for the flat slab roof of a building 12 feet by 14 feet in outside dimensions, with 12-inch eaves on all sides. The size of the roof slab between the center lines of walls will be 13 feet 6 inches by 11 feet 6 inches. Referring to Table F, we run down the vertical column at the left to the smaller dimension of the slab, which in this case is 11 feet 6 inches. As this dimension is not given in the table we take the next larger, which is 12 feet. Running across horizontally to the larger dimension of the slab (13 feet 6 inches) we find that this is not given in the table, but that we must take 14 feet. In the square

directly below 14 feet, and horizontally opposite 12 feet, we find the required thickness of the roof to be $4\frac{1}{2}$ inches. By reference to Table G the quantities of materials required are easily obtained. The size of the roof over the eaves is 14 feet by 16 feet. The table is divided into three parts showing respectively the amounts of cement, sand and gravel required for roofs of various sizes. The upper portion of the table gives the number of sacks of cement required and those below it give the number of cubic feet of sand and gravel or stone necessary. By referring to the table we find that the roof will require about 21 sacks of cement, 52 cubic feet of sand and 84 cubic feet of gravel or stone.

Table H
SPACING OF REINFORCING RODS IN INCHES

Width in Feet Between Center Lines of Walls	LENGTH OF ROOF IN FEET BETWEEN CENTER LINES OF WALLS							Size Steel
	4 Ft.	6 Ft.	8 Ft.	10 Ft.	12 Ft.	14 Ft.	16 Ft.	
4 Ft.	12 In. 12 In.	9 $\frac{1}{4}$ In. 24 In.	8 In. 36 In.	8 In. 36 In.	8 In. 36 In.	8 In. 36 In.	8 In. 36 In.	$\frac{1}{4}$ In. Rd. Rods.
6 Ft.	6 In. 6 In.	4 $\frac{3}{4}$ In. 12 In.	4 In. 36 In.	4 In. 36 In.	4 In. 36 In.	4 In. 36 In.	
8 Ft.	11 In. 11 In.	9 $\frac{1}{2}$ In. 22 In.	9 In. 36 In.	7 $\frac{3}{4}$ In. 36 In.	7 $\frac{1}{4}$ In. 36 In.	.....	$\frac{1}{8}$ In. Round Rods.
10 Ft.	8 $\frac{3}{4}$ In. 8 $\frac{3}{4}$ In.	7 $\frac{3}{4}$ In. 16 In.	7 In. 27 In.	6 $\frac{1}{2}$ In. 36 In.	.....
12 Ft.	6 $\frac{1}{2}$ In. 6 $\frac{1}{2}$ In.	5 $\frac{3}{4}$ In. 12 In.	5 $\frac{1}{4}$ In. 16 In.	.....	$\frac{1}{8}$ In. Round Rods.
14 Ft.	NOTE—Upper figures are for cross reinforcement; lower figures for long reinforcement	.....	5 $\frac{1}{4}$ In. 5 $\frac{1}{4}$ In.	4 $\frac{1}{2}$ In. 8 $\frac{3}{4}$ In.	.....
16 Ft.	4 In. 4 In.	.....	.....

Load = Weight of roof + 50 pounds per square foot.

The spacing of the reinforcing rods is shown in Table H. As the roof is 11 feet 6 inches by 13 feet 6 inches between center lines of walls, the next larger dimension shown in the table should be used. These are 12 feet by 14 feet. By running down the left hand vertical column to 12 feet, then running across horizontally to the 14 foot column, we find that cross reinforcement (running parallel to the short sides of the house) should be $5\frac{3}{4}$ inches apart, and the longitudinal rods (running the long way of the house), 12 inches apart. Round or square $\frac{1}{8}$ -inch rods should be used as shown in the column to the right of the table. The roof being 16 feet long and 14 feet wide, over eaves, will require $34\frac{3}{8}$ -inch rods 14 feet long, parallel to the short sides and $17\frac{3}{8}$ -inch rods 16 feet long parallel to the long side.

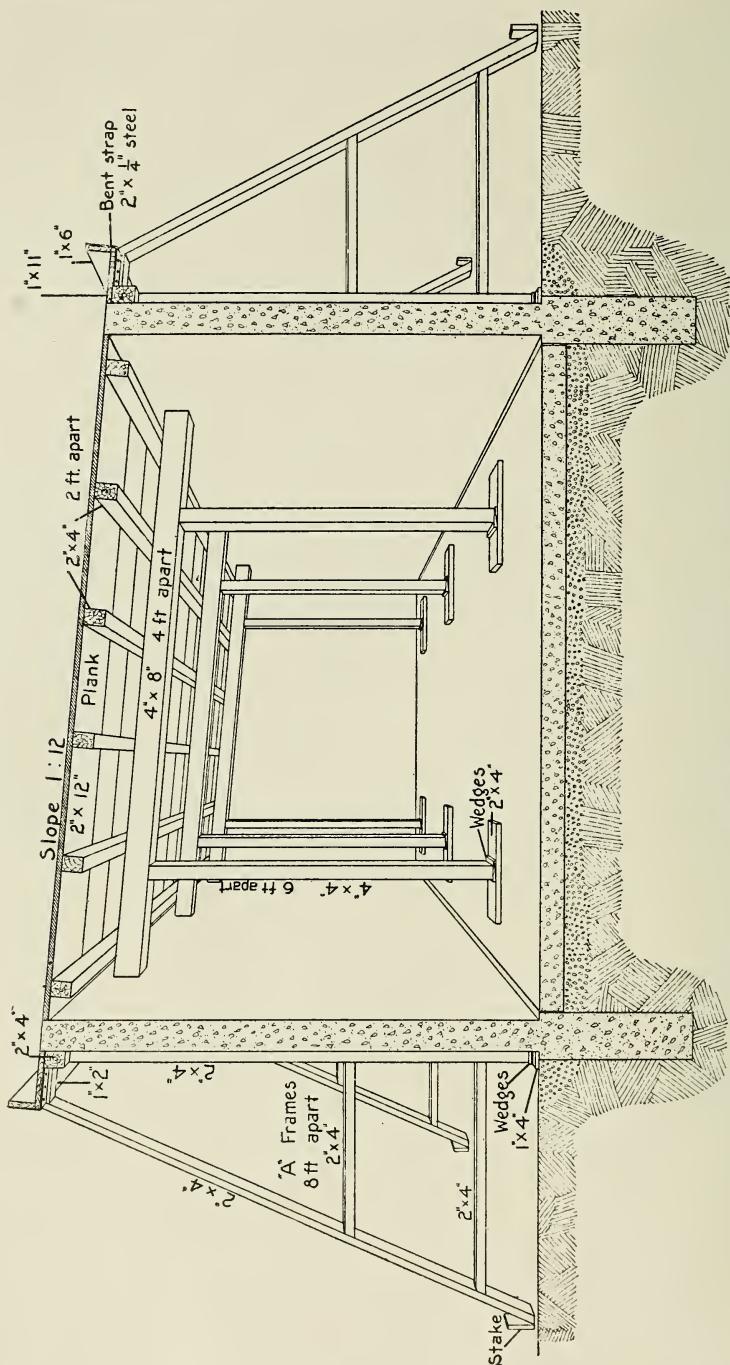


Figure 52. Forms in position for concreting flat slab roof and eaves.

Forms for Slab Roofs. A suitable method of constructing forms for flat slab roofs is shown in Figure 52. To insure a smooth ceiling the face of the planking next to the concrete should be dressed smoothly and tongued and grooved, although good results can be obtained with square edged lumber provided the edges are straight and in the same plane, so that no cracks will be formed between planks. Whitewash or crude petroleum oil applied to the surfaces of the lumber which will be in contact with concrete, is recommended, but if not used, these surfaces should be clean and wet at the time of concreting. Clay or putty may be used to smooth over small cracks or flaws.

Two-inch face lumber is recommended but lighter material may be used if sufficiently braced. Warped lumber should be avoided, although slight bows, lengthwise or crosswise will generally straighten out under the weight of the concrete. Lumber showing bowed edges should not be used unless the edges are redressed. All sizes shown in Figure 52 are stock sizes and readily obtainable. Forms can be erected without nailing or fastening except where specially directed and shown in the illustration; such fastenings should be avoided as they make the forms more difficult to remove and mar the timber for further use.

Erecting the Forms. In erecting forms the first step should be to divide the length of the floor beneath the roof by cross lines four feet apart. The posts to support the roof should be spaced six feet apart along these lines. These may be formed if desired by two 2 x 4's spiked together and may rest directly on the floor if the latter is of concrete or other firm material, but the better plan is to place short pieces of 8-inch plank under the ends of the posts. These also serve as a base for the wedges which are later to be placed under the ends of the posts to raise them to the proper level.

As the posts are raised, they can be braced lightly to the side walls and to each other. Posts on the same cross line are then connected at the top by 4 x 8-inch boards resting on edge, or two 2 x 8's nailed lightly together can be substituted by each 4 x 8. If these 2 x 8's are of proper length no stay bracing will be necessary. A light cleat nailed to the sides of the posts and the beams resting on them, will hold the bents together. The top of the beams should be about 6 inches below the top of the side walls, as the whole form will be trued up later by driving wedges under the bottom of the posts.

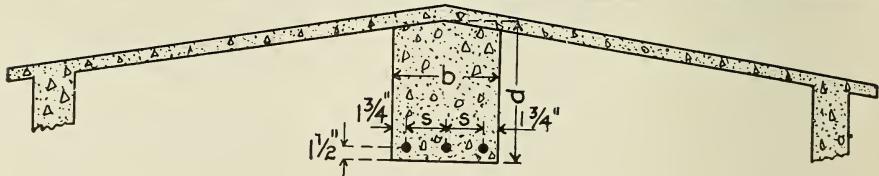
The stringers should be made of 2 x 4's two or three feet apart depending on whether one and one-half inch or two-inch face lumber is to be used. It is not necessary to spike these to the beams. On top of these are laid the face planks. The tops of the latter should be raised flush to the top of the side walls by driving wedges under the posts. These forms will support the concrete and the weight of the men during construction. Mixing boards or materials should not be placed on the roof forms, however, if any bending of the forms occurs after the placing of the concrete, nothing can be done to bring these back to their original place as any prying against them to line them up after they are covered will crack the concrete and spoil the work. If the directions given are strictly followed and the lumber is of good quality, no bending will occur.

The forms should be left in place at least ten days in moderate weather or longer at lower temperatures but should not be taken down until all doubts have been removed as to whether or not the concrete can support the loads to be imposed upon it. In removing the forms the wedges may be knocked out between the posts and the bents carefully let down. The face planks, if not very carefully prepared, may give some trouble by sticking, and may have to be loosened by slight jarring from a temporary scaffold. Prying against the concrete should be avoided. If necessary, hooks or staples can be inserted in the bottoms of the planks to which ropes can be attached to pull them down.

Gable Roofs. (Size of Beam). Simple gable roofs for small concrete buildings need consist only of a ridge beam and two side slabs, of reinforced construction; or if the building is less than 8 feet in length, the ridge beam may be omitted. The following table gives the size of ridge beam and reinforcing required for roofs 8 feet to 16 feet in length between walls or supports:

Table I
SIZES OF RIDGE BEAMS FOR GABLE ROOFS

Length of Roof	8 Ft.	10 Ft.	12 Ft.	14 Ft.	16 Ft.					
Breadth of Beam (b)	6 In.	8 In.	9 In.	10 In.	10 In.					
Number of Rods	2	3	3	4	4					
Spacing of Rods	2 $\frac{1}{2}$ In.	2 $\frac{1}{4}$ In.	2 $\frac{3}{4}$ In.	2 $\frac{3}{16}$ In.	2 $\frac{3}{16}$ In.					
Width of Roof	Depth of Beam Rods	Size Rods	Depth of Beam Rods	Size Rods	Depth of Beam Rods					
8 Ft.....	9 $\frac{1}{2}$ In.	$\frac{1}{2}$ In.	10 $\frac{1}{2}$ In.	$\frac{1}{2}$ In.	12 In.	$\frac{5}{8}$ In.	13 $\frac{1}{2}$ In.	$\frac{5}{8}$ In.	16 In.	$\frac{5}{8}$ In.
10 Ft.....	10 $\frac{1}{2}$ In.	$\frac{1}{2}$ In.	11 $\frac{1}{2}$ In.	$\frac{1}{2}$ In.	13 In.	$\frac{5}{8}$ In.	15 In.	$\frac{5}{8}$ In.	17 $\frac{1}{2}$ In.	$\frac{5}{8}$ In.
12 Ft.....	10 $\frac{1}{2}$ In.	$\frac{1}{2}$ In.	12 $\frac{1}{2}$ In.	$\frac{5}{8}$ In.	14 In.	$\frac{5}{8}$ In.	16 In.	$\frac{5}{8}$ In.	18 $\frac{1}{2}$ In.	$\frac{5}{8}$ In.
14 Ft.....	10 $\frac{1}{2}$ In.	$\frac{1}{2}$ In.	12 $\frac{1}{2}$ In.	$\frac{5}{8}$ In.	15 In.	$\frac{5}{8}$ In.	17 $\frac{1}{2}$ In.	$\frac{5}{8}$ In.	20 $\frac{1}{2}$ In.	$\frac{5}{8}$ In.
16 Ft.....	10 $\frac{1}{2}$ In.	$\frac{1}{2}$ In.	12 $\frac{1}{2}$ In.	$\frac{5}{8}$ In.	15 $\frac{1}{2}$ In.	$\frac{5}{8}$ In.	17 $\frac{1}{2}$ In.	$\frac{5}{8}$ In.	22 In.	$\frac{3}{4}$ In.



The ridge beam may either be cast in place or in a mold box on the ground. The latter method insures proper curing of the beam before it is subjected to loads, but is objectionable because of the weight of the beam and the consequent trouble in raising it into place. If the beam is cast in position it can be made in a simple box mold supported on the same framing erected to carry the side slabs. Concrete should, in this case, be placed for beams and slabs at the same time, casting them together as a monolith.

Size of Slabs. To find the thickness of slab necessary for a gable roof from 8 feet square to 16 feet square (between supports) refer to

Table F on page 59. Thus, for the roof of a building 10 feet wide by 12 feet long, with the beam 12 feet in length (running the long way of the building) two slabs each 5 feet wide by 12 feet long (between supports) will be required. The above table gives the thickness of slab required, and Tables G and H give respectively the amount of concrete materials and reinforcing required.

Forms for the Eaves. The eaves can be formed by means of a mold made of three 2-inch boards joined by $2'' \times \frac{1}{4}''$ iron angle straps every five feet. Two of these boards should be wide enough to form the desired projection and the other wide enough to confine the concrete to the depth desired. The mold can be made of any convenient length, being fastened to the adjoining section after erection by light cleats.

The molds for the eaves may be secured in place in several ways. If the side walls are of monolithic construction and the forms still in place, steel or wooden brackets can be fastened to the studding for the support of the eave mold. In case this scheme is not available, the eave mold box can be supported at intervals of four or five feet by "A" frames, as shown in Figure 52. Unless waste lumber of some kind is available for use in the "A" frames, these need not be used if the mold box can be supported conveniently by the forms or staging.

Placing the Reinforcing. The required number of reinforcing rods, their size and spacing, having been obtained from Table H, these rods may be ordered from the local dealer or blacksmith. The spacing of the rods should be marked off on the forms, and the rods then laid down and wired together at all intersections. The reinforcing should then be placed upon small wooden or concrete blocks in such a manner that the rods will be imbedded about one inch above the bottom of the roof. It is very important that the rods should not come closer than one inch to the bottom surface of the roof; and, on the other hand, the effectiveness of the reinforcing is reduced greatly if they are placed any higher.

Reinforcing in Gable Roofs. The slab reinforcing rods running at right angles with the ridge should extend from eave to eave continuously, that is, not being broken off at the ridge. This binds the two sides of the roof together as one slab. The reinforcing should be brought out for the eaves in the same manner as for simple slab roofs.

Mixing and Placing the Concrete. It should be remembered that a concrete roof is intended to be a permanent roof, and that all work should be done in the best possible manner. There is often a tendency in the mixing and placing of concrete to be careless or "slipshod" but nothing short of the best workmanship and materials should go into the construction of the concrete roof.

Concrete for the roof should be mixed in the proportion of 1 sack of cement to $2\frac{1}{2}$ cubic feet of clean, coarse sand to 4 cubic feet of screened gravel or crushed stone. Great care should be taken to see that the sand and stone used are free from clay, loam, decayed rock, or other weak or injurious matter. It is not good practice to use bank run gravel; much better results can be obtained with a saving of cement by screening out all material less than $\frac{1}{4}$ -inch in size to be used as sand, retaining the larger materials to be used as gravel proper. If bank run gravel

is used, the proportion should be no leaner than 1 sack of cement to 4 cubic feet of gravel. Where crushed stone is more easily obtained than sand and gravel, this material may be substituted, care being taken, however, to screen out all excessively fine particles and dust.

The concrete should be mixed thoroughly. Place the cement and sand (or other small aggregate) on the mixing board and turn together until the mass is uniform in color. Then add the large gravel or stone and add the water. Turn the mixture at least three times, after adding the stone, using additional water as required. The concrete should be mixed wet enough to be quaky, but not so wet that the water in the mass will flow to the lower side of the roof.

Where a comparatively flat concrete roof is to be put on a building with monolithic walls, the walls may be brought up to the proper height and squared off in the same manner as for a wooden roof, and no reinforcing rods need extend from the walls up into the roof. The concrete for the roof may be laid directly on the top surfaces of the walls without grouting. This leaves a break or parting between the roof and the walls, which allows the former to expand and contract freely with change of temperature.

If the roof is to have a pitch steeper than 2 inches to the foot, it is advisable to join it to the walls. This is necessary to prevent slipping or traveling of the roof. Where the walls and roof are to be joined together rigidly, the vertical reinforcing should protrude about a foot above the top of the walls. The top surface of the walls should be left rough, and should be drenched with water, and then painted with a grout immediately before the concrete for the roof is placed.

The same equipment used to convey and raise the concrete in the walls can generally be used for the roof. With the reinforcing metal placed in position, as previously mentioned, enough mortar should be placed on the floor of the forms to work under the reinforcing. The blocks used to hold the rods up off the forms may then be withdrawn, and the spaces occupied by them filled up. Concreting must not be stopped until the entire thickness of the roof, including the surfacing, has been put on. Small concrete slab roofs should be concreted entirely at one operation, that is, without stopping work at any time for more than twenty minutes. Larger roofs may be laid in sections, as mentioned on page 140, discontinuing and resuming of the work as directed there.

Finishing the Roof. The roof should be finished off in the same manner as a floor or a sidewalk, using for this work the tools shown in Figure 20. If the concrete, mixed in the proportion of 1 sack of cement to $2\frac{1}{2}$ cubic feet of sand to 4 cubic feet of small stone does not give a sufficiently smooth surface when trowelled, a small quantity of mortar may be added to the top. The roof need not be squared off into panels.

Protection Against Weather. One of the most important points in successfully constructing concrete roofs is to protect them from the time they are laid until they have hardened sufficiently, and acquired ample strength to withstand the action of sun, wind, rain and freezing. This may be done conveniently by covering the roof with wet straw, weighted down to keep it in place. The straw should be kept wet, and

not removed from the roof for at least two weeks. Precautions in this regard are necessary to insure against possible checks or cracks caused by premature exposure to sun or wind, and also prevent freezing, with consequent loss of strength.

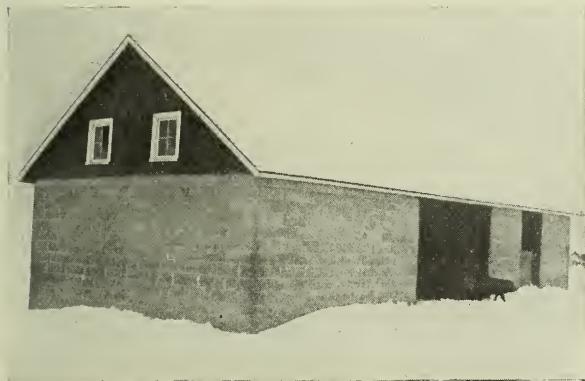


Figure 53. Monolithic Ice House and Dairy of C. H. Zehnder,
Allenhurst, N. J.

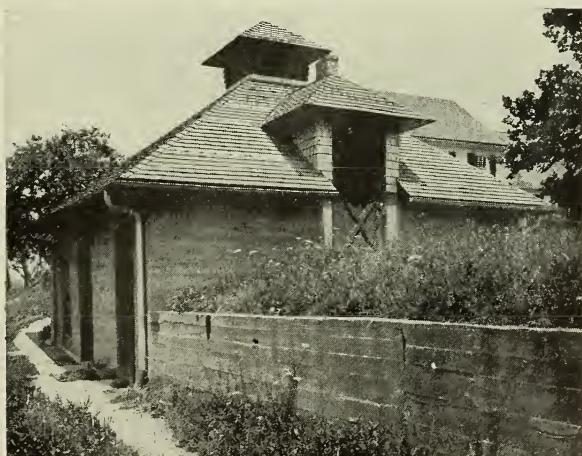


Figure 54. Concrete Block Cattle Shed on farm of N. Hampe,
Rock Rapids, Iowa. Dimensions 30 feet by
40 feet. Cost, \$300.

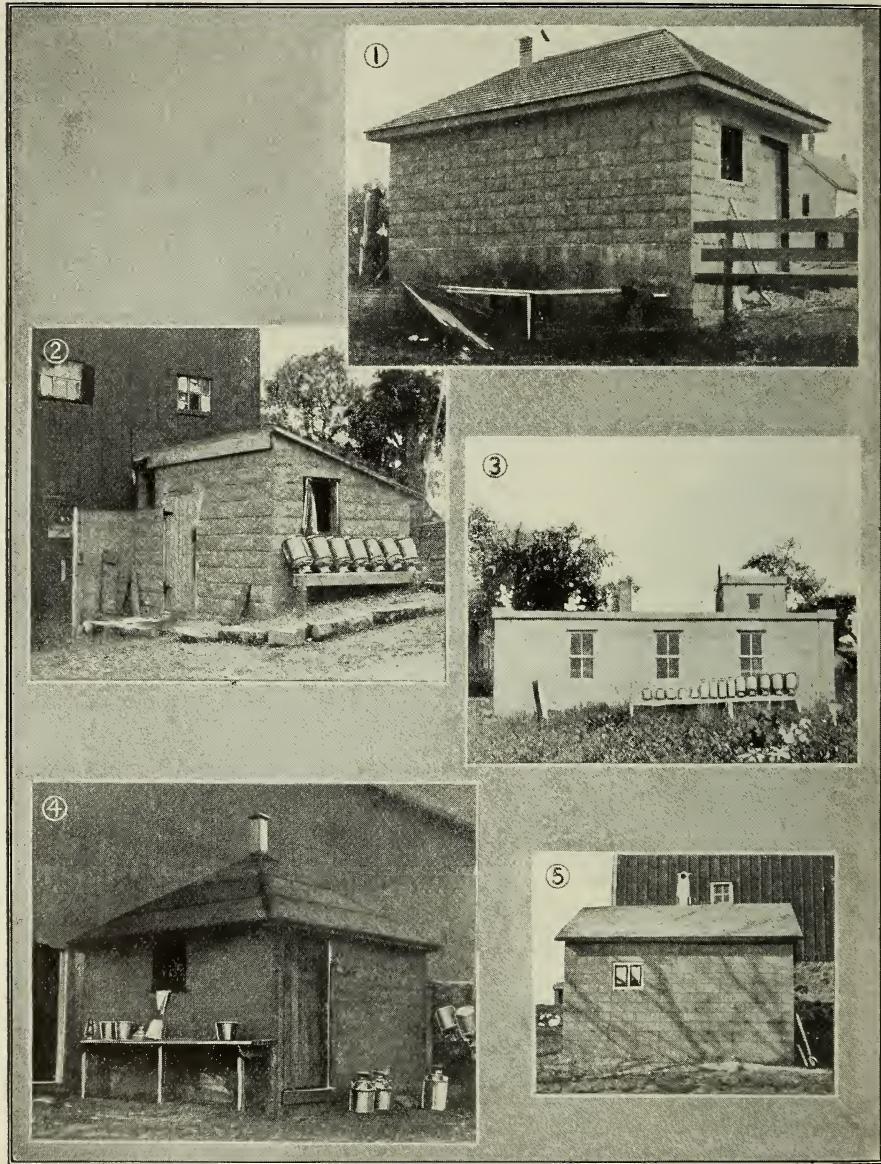


Figure 55. CONCRETE DAIRY HOUSES.

- (1) J. M. Thalin, McHenry, Illinois. Built by owner.
- (2) C. S. McNett, Cary, Illinois. Built by owner.
- (3) Beech Farm Dairy, Coldwater, Michigan. R. C. Angevine, Contractor.
- (4) Wm. Fareman, Burlington, Wisconsin. Built by owner.
- (5) Merestead Farm. Built by owner.

PART II.

Dairy Buildings

THE dairy is the department of the farm where absolute cleanliness is demanded. The first great requirement of a dairy building is that it be scrupulously clean. There should be no decaying wood construction to serve as a breeding place for germs, and no cracks or crevices in the floor or walls to collect dirt and make proper cleaning difficult or impossible.

The rules and regulations of the New York Board of Health prescribes, among other things, that (1) Milk houses must be kept clean and used for no other purpose than the handling of milk. (2) They shall be provided with sufficient light and ventilation, with floors properly graded and watertight. (3) They shall be provided with adjustable sashes to furnish sufficient light, and some proper method of ventilation must be installed. (4) Milkhouses should be provided with ample supply of clean water for cooling the milk, but if it is not a running supply the water should be changed twice daily. (5) Milk houses must be screened properly to exclude flies.

The health officials of Chicago, as well as those of numerous other large centers of population, now require farmers shipping milk into the city to provide their milk houses with concrete floors, and the trend in all of the great dairying communities of the country is clearly toward all-concrete construction for such buildings. Beside the advantage of cleanliness, the concrete dairy house adds greatly to the general convenience of handling the milk and keeping it cool, and, when properly put up, constitutes the most permanent form of construction possible. It is free from the necessity of frequent painting and repairs, and this item alone is quite important. The difference in cost between wooden and concrete dairy buildings is insignificant in most cases, and several instances have been found where concrete was actually cheaper than wood.



Figure 56. Concrete Block Milk House of Mrs. Godfrey Anderson, Elgin, Illinois.

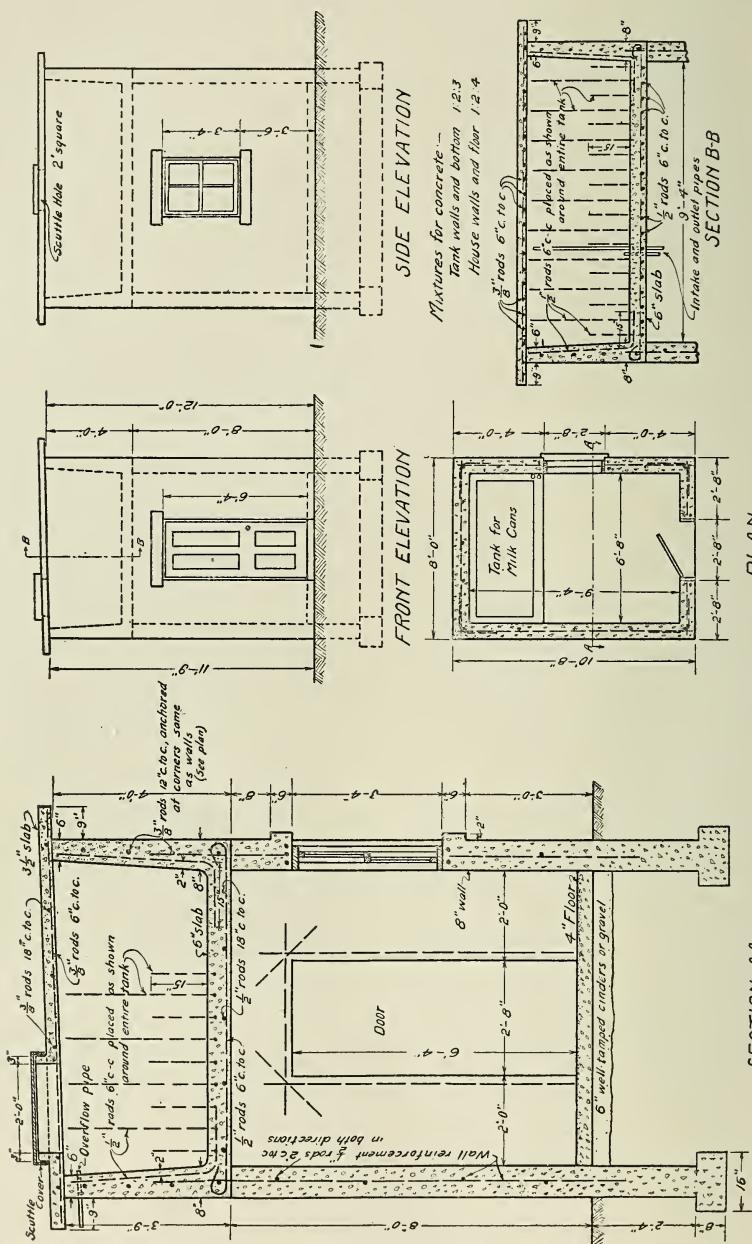


Figure 58: Reinforced Concrete Mills House with Overhead Water Supply Tank.

Location of Dairy Buildings. The milk house or other dairy building should be located conveniently with respect to the dairy barn. Dairy houses frequently adjoin the barn, or are built under an approach to the second floor. If this be done, the milk house must have no direct connection with the barn, and must be separated by a solid wall, without doors. Many authorities maintain that the milk house should be built entirely separate from the barn and at some distance; while not considered necessary in all cases, it is undoubtedly a good precautionary measure.

It is best to locate the milk house on elevated ground, and to comply with health department regulations in sections of the country subject to inspection, that no hog-pen, manure pile or other unsanitary object shall be closer than 100 feet. After considering the location with regard to the sanitary requirements, the site selected should be as near as convenient to the milking floor, so that the distance the milk has to be carried will be made as short as possible. In Circular No. 143 by the Illinois Experiment Station, Professor W.

J. Fraser says:

"People do not stop to consider the amount of time that might be saved if a little more intelligence were exercised in tasks done two or three times each day. To illustrate this, take the matter of having the milk room inconveniently located. If the milker carries the milk of each cow 50 feet farther than need be, that means three rods and back each milking, or twelve rods per cow each day. If a man milks 12 cows it causes the extra labor of carrying a pail of milk 72 rods and carrying back the empty pail each day."

A location to the north of the barn is preferable, as it keeps off the warm rays of the sun. Where an approach to the second floor of the barn is to be built, there are a number of advantages in locating the dairy room under this approach. By so doing, the walls of the approach are made to serve a double purpose, the heavy roof over the dairy room keeps it cool, and the location is convenient.



Figure 57. Concrete Block Milk House of Theodore Alby, Rochester, Wisconsin. J. A. Kilpatrick, Contractor. Dimensions, 12 feet by 10 feet. Cost, \$125.

A Reinforced Monolithic Milk House with Water Supply Tank

THE reinforced monolithic milk house shown in Figure 58, will be found well suited to the needs of the average small dairy farm. The building is 10 feet 8 inches by 8 feet in outside dimensions and slightly more than 12 feet in height from the ground line to the top of the roof.

It is provided with a water supply tank with a capacity of 23 barrels or 725 gallons, and a cooling tank of sufficient size to accommodate ten 14-inch milk cans. In case the owner has a more desirable location for the supply tank or for any reason he does not wish to place a supply tank on the structure, the roof may be built directly above the milk room, omitting the tank.

The foundation may be placed without forms if the ground is firm enough to stand up around the excavation, which should be 3 feet or more in depth and 12 to 16 inches in width. If the ground is of such a character that forms must be used, the type of foundation shown in the illustration will be the most economical to put in. In this case, the footing (16 inches wide and 8 inches in depth) may be put down without forms. The wall forms may then be placed directly upon the footing, continuing the foundation up to the surface with the same width as that of the wall above ground, or allowing it to bulge to the width of the footing by tilting the forms.

The work of building the walls and roof may be accomplished in accordance with the suggestions for such construction given in Part I. of this volume. The method of placing and the proper spacing of wall reinforcing around openings and at corners is shown in Figures 35, 36, 37 and 38. The door and window openings are made by placing temporary wooden frames within the forms at the proper positions. The sill and lintel projections around the opening may be formed by small box-like additions built or clamped into the wall forms as shown in the design of a Monolithic hog house, Figure 121,



Figure 59. Monolithic Milk House of John Rhinehardt, Elgin, Illinois. The walls are marked off in imitation of concrete blocks. Dimensions, 10 feet square by 8 feet in height.

page 139. The vertical reinforcing should extend up about 20 inches above the bottom of the tank floor.

Forms for the floor of the supply tank may be put up as shown in Figure 52, or if preferred the tank floor forms can be supported upon the wall forms if the latter are built substantial enough to take the weight of the concrete placed in the tank floor as well as that of the forms. The

floor reinforcing should consist of $\frac{1}{2}$ -inch round or square rods spaced at intervals of 6 inches across the short dimension of the structure (shown in Section B-B Figure 58) and at intervals of 18 inches parallel to the long dimension of the structure (shown in section A-A Figure 58). The ends of these reinforcing rods should be brought around the wall reinforcing and bent back into the floor of the tank to develop maximum strength. The reinforcing should be placed an inch above the bottom of the floor, with ends bent back above the reinforcing, as shown

After the forms for the floor are in place the reinforcing rods should be laid down and wired together. One inch of concrete (of a quaky consistency) should then be placed within the forms and the reinforcing raised up so as to rest on the one-inch layer of concrete. Before this concrete has had a chance to harden, three inches more concrete should be put down and leveled off, and the reinforcing for the wall of the tank then placed.

The tank wall reinforcing should consist of $\frac{1}{2}$ -inch rods bent in such a manner that 15 inches of their length will be imbedded in the floor. These rods are placed 6 inches apart, center to center, all around the tank, each alternate rod being 5 feet long so as to extend to the top of the tank wall, with the intermediate rods 32 inches long, which allows them to extend up about 15 inches above the floor slab. The reinforcing rods should be bent ready for use before the work is begun, and should be placed and wired as rapidly as possible so that concreting may be resumed immediately. Two inches of additional concrete will bring the floorslab to the required thickness, which is 6 inches.

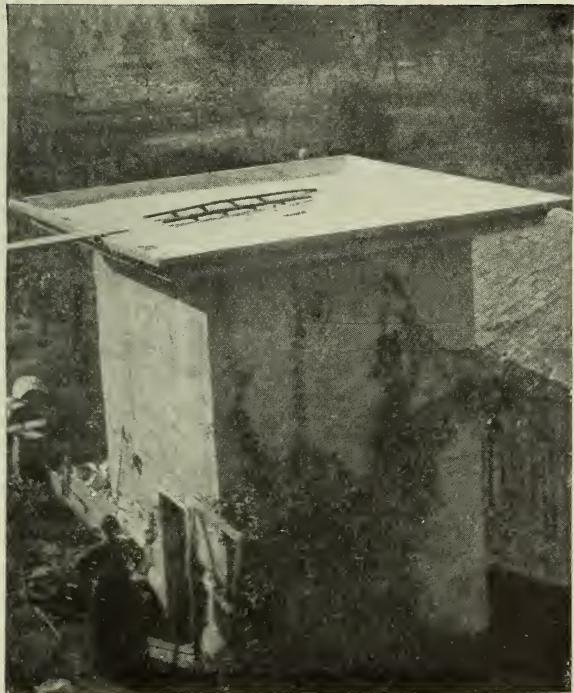


Figure 60. Concrete Dairy House and Water Tank of Joseph E. Wing, Mechanicsburg, Ohio, showing the flat slab concrete roof with ornamental cornice.

The outside wall form will serve as the outer form for the tank wall, and the inner wall form may be used as the inner form of the tank. In order to insure against damage from freezing, the inner walls of the tank must have a slight batter, making them 8 inches thick at the tank floor tapering to a thickness of 6 inches at the roof. If the inner walls

are made smooth and the work done as here directed, this batter should be sufficient to withstand any ice pressure which may come upon the tank. The forms used for building the floor of the tank may be used for the roof, provided a sufficient length of time has elapsed so that they may be safely removed. The forms should be allowed to remain in place until there are no doubts as to whether or not the floor has acquired sufficient strength to withstand the loads imposed upon it. Even under the most favorable circumstances the forms should remain in place five or six days, but under unfavorable conditions two weeks or longer may be required.

General directions for placing the reinforcing and building the eaves and other general operations about the roof will be found in the chapter on roofs, page 58. A scuttle hole 2 feet square should be left in the roof as shown in Figure 58. In putting up the roof forms and inner tank wall forms it must be remembered that these will have to be taken out through the scuttle hole. For this reason it would probably be advisable to use short lengths of lumber for this work as it may have to be damaged in removing from the tank. For this work only the use of lumber of uniform thickness is advisable.

The intake and outlet pipes for the water supply tank should be put up before the tank floor is concreted, drilling holes through the forms to accommodate the pipes. This method is the only satisfactory way of placing the pipes without danger of leaks.

Proportions (See page 157). Footings, foundation walls and floor base, Specification D. Wall from ground to bottom of tank, and tank roof, Specification B. Walls and floor of tank, Specification A.



Figure 61. Concrete Block Milk House with ice room and water tank, on farm of M. D. Campbell, Coldwater, Michigan.

Table of Concreting Materials

	VOL Cu. Yds	MIXTURE	CEMENT		SAND		STONE	
			Bbls.	Sacks	Cu.Yds.	Cu.Ft.	Cu.Yds.	Cu.Ft.
Footings.....	1.15	1:2½:5	1.43	5.72	.51	13.8	1.02	27.5
Foundation Walls.....	2.00	1:2½:5	2.48	9.92	.92	24.7	1.84	49.5
Wall from Tank bottom to ground.....	6.22	1:2:4	9.40	37.60	2.80	75.5	5.55	150.0
Floor.....	0.55	1:2½:5 (1:2)	.96	3.74	0.20	5.4	.38	10.5
Tank Floor.....	1.15	1:2:3	1.90	7.60	.60	16.2	.88	23.8
Tank Walls.....	2.62	1:2:3	4.56	18.24	1.36	36.7	2.02	54.5
Roof.....	1.27	1:2:4	1.93	7.72	.57	15.4	1.13	30.6

Total..... 22.66 Bbls. 4.96 Cu.Yds. 12.82 Cu. Yds.

Approximate amount of Reinforcing Metal required:

800 feet of $\frac{1}{2}$ -inch round rods..... Weight 533 Lbs.
460 feet of $\frac{3}{8}$ -inch round rods..... Weight 173 Lbs.

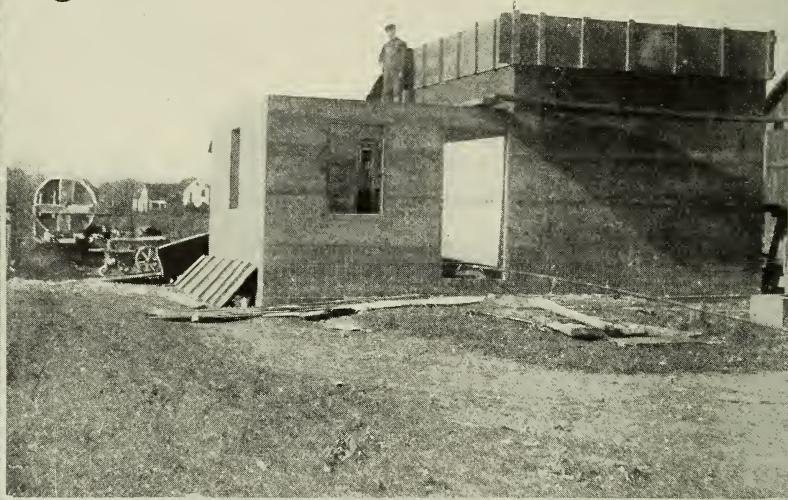
Total..... 706 Lbs.

The table of concreting materials will be found accurate to within 10 per cent. In computing the amount of reinforcing metal no allowance was made for scrap or lapping, which will require about 10 per cent more material than the quantity stated.



Figure 62. A splendid monolithic concrete dairy house built by Edward Kuharske, on his farm near Rockford, Illinois. This building contains two commodious milk and separator rooms as well as a shelter for wagons. The shelter is on the north side of the house, and prevents the sun from reaching the south walls of the dairy rooms.

(1)



(2)

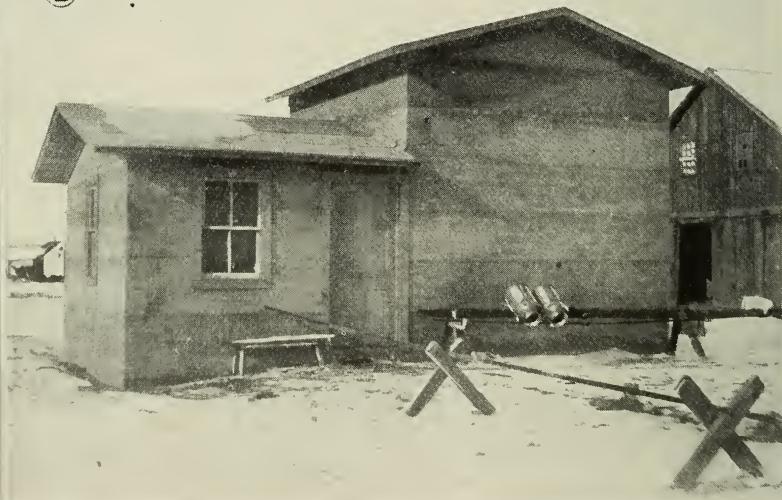


Figure 63. MONOLITHIC MILK AND ICE HOUSE.

Julius Clausing, Grafton, Wisconsin.

(1) Incomplete structure with forms on the walls of the ice room in position for last filling.
(2) Building completed. The walls are 6 inches thick. All the work was done by the owner.

Reinforced Concrete Milk House with Ice Room

AN ice room is often a great convenience in connection with the milk house, giving easy access to the ice for use in the cooling tank. Figure 65 shows a house with a large milk room and an ice storage room of ample capacity. The inside dimensions of the milk room are 9 feet 4 inches by 11 feet 8 inches, in which is located a cooling tank with space for 18 14-inch milk cans. The ice room is 10 feet square in inside dimensions, and has a height of 8 feet in the clear, giving it a capacity of 15 tons of ice. Allowing for shrinkage and waste, this should leave a sufficient quantity so that about 115 pounds per day will be available for four months.

The walls of the ice room should be made double, or a wall of veneer blocks may be constructed inside of a single monolithic wall, thus providing a free air space in either case. Double doors are provided for the ice room, and sawdust or some other good insulating material should be packed between doors. These doors should be lined with felt or other packing which will make them air-tight. The door to the ice room should be made in two or three sections so that in removing ice from the top only the first section need be opened, thus protecting the ice from an inrush of warm air. The milk room is provided with two doors, the one near the ice room door being used exclusively for bringing in the ice and the other door being used for the handling of the milk cans.



Figure 64. Concrete Block Milk and Ice House of J. A. Johnson, Libertyville, Illinois. The milk house is placed to the north of the barn, the shadows of which prevent the sun's rays from reaching the walls of the ice room except for a short time each day.

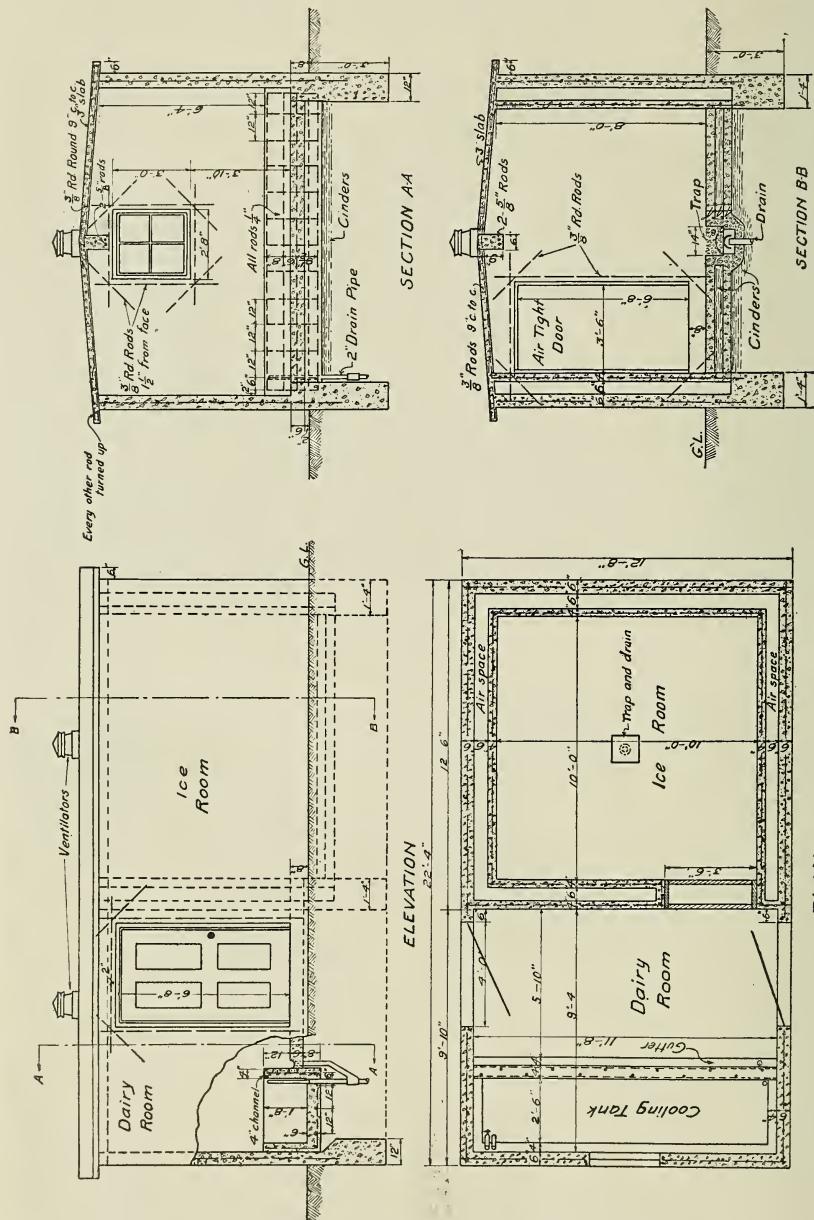


Figure 65. Reinforced Concrete Milk House with Ice Room.

Directions for building the monolithic walls, floors and roof will be found in Part 1 of this book. The ventilators provided in the roof are an important feature which should not be overlooked. Plenty of pure air is needed in the milk room to keep the milk pure and free from contamination. The ventilation in the ice room prevents the accumulation of warm air above the ice.

For best results, the floor of the ice room should be double with a layer of cinders or other insulating material between. The space between foundations should be excavated until a depth of about 16 inches is reached. Four inches of gravel should then be put down as a sub-base for the floor and leveled off. A four-inch floor should next be put down and leveled off without giving it any surface finish. After placing 4 inches of cinders on top of this floor another slab similar to the first should be laid upon the cinders. As a precaution against possible cracking, the upper slab should be reinforced with a light fabric. Style No. 29, American Steel & Wire Company's Triangle Mesh, or some similar material, is suitable for this purpose. About two inches of concrete for the floor should be placed and leveled off, and the metal fabric then laid down. Concreting should immediately be resumed to insure a good bond between the concrete below and above the fabric.

The surface of the floor will not require a mortar top, but should be troweled off with a wooden trowel, using a small amount of mortar if necessary to make the surface sufficiently smooth. The surface should be given a slight slope—not over $\frac{1}{8}$ -inch to the foot—toward a central drain. Details of a suitable drain outlet are described on page 94, and shown in Figure 76, in connection with the concrete block ice house design. The milk room tank and floor should be put in the same as those previously described.

Proportions (See page 157).

Foundation and base of dairy room floor, Specification D.

Floor of Ice Room, Specification C.

Walls, roof beam and slab, cooling tank, Specification B.

Surface coating dairy room floor, 1:2 cement and sand mortar.

Table of Materials

	VOL Cu. Yds	MIX- TURE	CEMENT Bbls. Sacks	SAND Cu.Yds. Cu.Ft.	STONE Cu.Yds. Cu.Ft.
Foundation.....	9.63	1:2 $\frac{1}{2}$:5	11.94 47.76	4.43 119.6	8.86 238.8
Ice Room Floor.....	2.48	1:2 $\frac{1}{2}$:4	3.45 13.80	1.26 34.0	2.03 54.8
Dairy Room { Base.....	1.11	1:2 $\frac{1}{2}$:5	1.38 5.52	0.51 13.8	1.02 27.6
Floor { Surface.....	0.22	1:2	0.71 2.84	0.21 5.6	.....
Walls.....	12.52	1:2:4	18.91 75.64	5.63 152.0	11.26 304.2
Roof Beam.....	0.30	1:2:4	0.45 1.80	0.14 3.8	0.28 7.6
Roof Slab.....	3.03	1:2:4	4.58 18.32	1.36 36.8	2.72 73.5
Cooling Tank.....	1.26	1:2:4	1.90 7.60	0.57 15.4	1.14 30.8

Total..... 43.32 Bbls. 14.11 Cu.Yds. 27.31 Cu. Yds.

Reinforcing Metal required:

775 feet of $\frac{3}{8}$ -inch round rods..... Weight 290 Lbs.

150 feet of $\frac{1}{4}$ -inch round rods..... Weight 25 Lbs.

Total..... 315 Lbs.

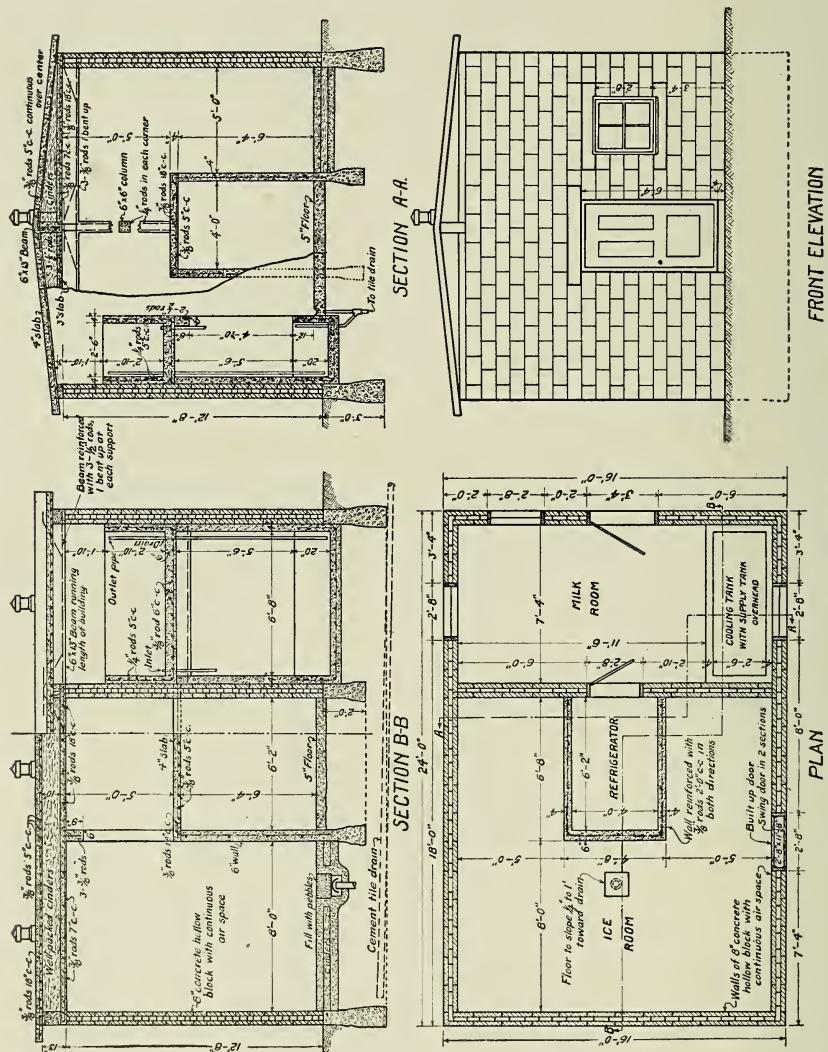


Figure 66. Concrete Block Dairy House with Ice Storage and Cold Room.

Concrete Block Dairy House with Cold Room

A DESIGN and detail for a concrete block dairy and ice house of moderate size is shown in Figure 66. The dairy room contains two tanks, one directly above the other. The elevated tank receives the water direct from the well and overflows through the outlet pipe into the milk cooling tank directly below. The dairy room has a clear space 11 feet 4 inches by 7 feet 4 inches, making plenty of room for the separator, butter worker and work table. Three windows 2 feet 8 inches wide by 2 feet 8 inches long admit ample light.

The refrigerator or cooling compartment opens off the dairy room and is surrounded by the ice room. This compartment is 6 feet long by 5 feet 4 inches wide and 6 feet high, giving plenty of room for the storage of milk, butter, cheese, eggs and other farm products. The design of the ice room and cooling compartment has been worked out with the idea of obtaining the maximum cooling surface with the expenditure of the smallest amount of ice. This has been accomplished by placing the cooling compartment within the ice room so that four sides of the former will be surrounded by ice. As the ice melts around the walls of the cooling compartment more ice can be packed in close to the wall to take the place of that melted. This arrangement of the cooling compartment partially overcomes the necessity of carrying ice into the dairy room.

The foundations for this building should be put in as directed in a previous section. The walls of the building are to be made of concrete blocks, the design being worked out for standard size (8x8x16-inch block) to be laid up as directed on page 46. The partition wall between the ice house and the dairy room should also be made of concrete blocks. The cooling compartment should be made monolithic rather than of hollow blocks as the monolithic wall makes a much better conductor of heat and cold than the block wall. The walls of the cooling room should be reinforced according to the directions given on pages 39 to 44 as shown in Figures 35 to 38.

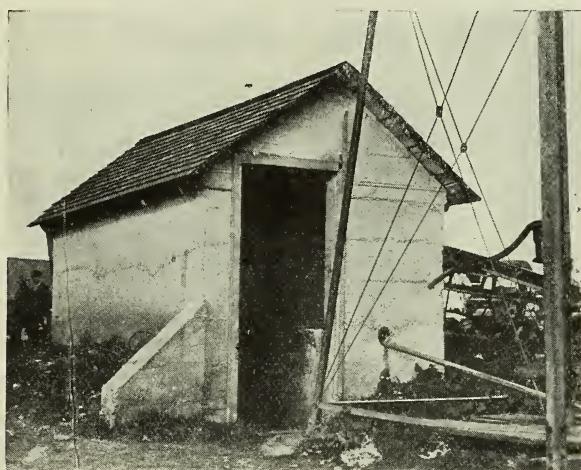
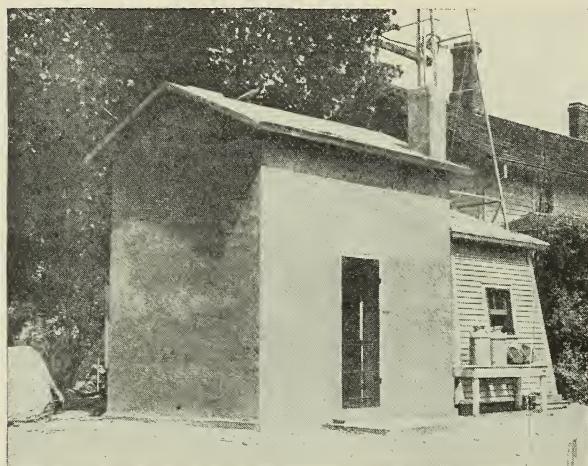


Figure 67. Monolithic Milk House of Charles S. McNett, Cary, Ill. One of a dozen concrete structures on Mr. McNett's Farm.

The roof of the cooling or refrigerator compartment should consist of a flat slab 4 inches thick cast in position and reinforced with $\frac{3}{8}$ -inch round rods spaced 5 inches apart, crosswise of the compartment, and 18 inches apart in the other direction. A 6 x 6-inch column to support the roof beam above must rest upon the slab as shown and the column reinforcing, consisting of four $\frac{1}{4}$ -inch rods, should be imbedded in a slab at the time of concreting. The column should next be put in, using a common box mold similar to that shown in the root cellar design Figure 131. The reinforcing rods should extend up about a foot above the top of the column, so that they may be anchored into the beam above.

The roof of the house is of double construction made of a level and a pitched monolithic section supported on the walls of the building, the partitions between the milk room and the ice room, and a concrete beam 6 inches in width and 9 inches in depth across the ice room wall

parallel to the partition. A concrete ridge beam 6 inches in width and 13 inches deep supports the upper slab and gives it the desired pitch. After the walls of the building are run up to the desired height the forms should be placed in position for the 6x9 roof beam, the flat section of the roof, the ridge beam and the end partition between the level and the pitched sections of the roof. The level roof slab should be made 3 inches thick and rein-



Monolithic Milk House and Water Tank on top. M. G. Clark, Owner, Coldwater, Michigan. R. C. Angevine, Contractor.

forced with $\frac{3}{8}$ -inch round rods 7 inches apart, center to center, the long way of the structure and 18 inches apart, center to center, the short way of the structure, placed one inch above the bottom of the slab. The beam below the slab should be reinforced with three $\frac{3}{8}$ -inch round rods placed as shown in sections A-A and B-B, Figure 66. The ridge beam should be reinforced with three $\frac{1}{2}$ -inch rods as shown.

The level section of the roof, the 6" x 9" beam below it, the end partitions between the level and the pitched sections, and the ridge beam are then concreted. The roof beam mold should be removed as soon as possible without injury to the beam. The forms supporting the roof slab and the beam below it should not be removed immediately however, but left in position until after the top roof slab has been concreted and all parts of the roof have acquired strength enough to support the loads imposed upon them. The upper roof slab should be concreted as soon as the level slab has been completed and the spaces between the level and pitched sections are filled up with cinders or some other

insulating material. For general information on the subject of roofs see pages 58 to 67.

The door opening between the milk room and the cooling compartment is 3 feet wide x 6 feet high and should be built with double walls forming a space which may be filled with shavings, sawdust, ground cork or some other good insulator if desired. The door opening into the dairy room from the outside is 4 feet wide and 6 feet 8 inches high. The ice room door is 2 feet 8 inches wide and extends the entire height of the building. It is built in several sections so that it is not necessary to open up the whole doorway thus exposing the ice to the warm air from without.

The lintels and window sills may be cast in a home made mold similar to that shown in Figure 40, page 45, or may be purchased from a local concrete block manufacturer. The cooling tank in the milk room should be constructed in accordance with directions given on page 88 and the concrete floors laid.



Figure 68. An Extensive All-Concrete Dairy Plant on the Gedney Farms, White Plains, New York.

Table of Concreting Materials

	VOL Cu. Yds	MIX- TURE	CEMENT		SAND		STONE	
			Bbls.	Sacks	Cu.Yds.	Cu.Ft.	Cu.Yds.	Cu.Ft.
Foundation.....	6.65	1:2½:5	8.25	33.00	3.06	83.00	6.12	165.00
Floor { Base.....	1.77	1:2½:5	2.19	8.76	.81	21.80	1.62	43.8
	.36	1:2	1.16	4.64	.34	9.20	.....	.....
*Walls (Block) { Body.....	.....	1:2:4	24.50	97.80	7.34	189.00	14.45	391.00
	.....	1:2	4.80	19.10	1.41	38.20	.....	.....
Walls of Cold Room	1.92	1:2:4	2.90	11.60	0.87	23.50	1.71	46.20
Roof of Cold Room.....	.82	1:2:4	1.24	4.96	.37	10.06	.73	19.80
Roof Beams	1.63	1:2:4	2.47	9.88	.74	20.00	1.46	39.50
Roof Slabs.....	9.00	1:2:4	13.60	54.40	4.04	190.80	8.00	216.00
Supply Tank.....	3.10	1:2:3	5.40	21.60	1.62	43.80	2.39	64.80
Sills.....	.62	1:2:3	.94	3.76	.28	75.80	.55	14.90
Total.....	67.45	Bbls. ..	20.98	Cu. Yds. ..	37.03	Cu. Yds. ..		

*The outside walls of the building require 931 standard 8"x8"x16" concrete blocks, and the partition between the milk and ice rooms 179 blocks. If these blocks are purchased from a block manufacturer the quantities of materials given for the blocks should be deducted from the total. One cubic yard of 1:2 cement and sand mortar will be required in laying up the blocks. This mortar will require about 13 sacks of cement and 26 cubic feet of sand. Total amount of materials necessary, including amount required for manufacture of blocks and for mortar, 71 bbls. cement, 22 cubic yards of sand, 37 cubic yards of stone. If the blocks are purchased from a block manufacturer, 38½ bbls. of cement, 14½ cubic yards of sand and 22½ cubic yards of stone will be required.

Approximate amount of Reinforcing Metal required:

3900 feet 1/4-inch round rods.....	Weight	830 Lbs.
290 feet ½-inch round rods.....	Weight	250 Lbs.
160 feet 5/8-inch round rods	Weight	45 Lbs.
Total.....		1125 Lbs.

Proportions (See page 157). Foundations and floor base, Specification D. Concrete Block backing, walls and roof of cold room, roof beams and slabs, Specification B. Supply tank, sills and lintels, Specification A.

Small Reinforced Concrete Milk House with Loading Platform

WHERE it is convenient to have a platform from which to load or unload milk cans the design shown in Figure 69, will give satisfaction. The milk house is 10 feet 8 inches by 8 feet 8 inches inside dimensions. Should it be desired, the walls may be conveniently built of concrete block, as the standard size (8" x 8" x 16") concrete block will conform nicely to these dimensions. The platform is on the side of the house opposite the cooling tank and double doors are here provided. The door for ordinary use is at the end of the house and is reached by four concrete steps. The tank will accommodate fourteen 14-inch milk cans, being 2 feet 6 inches in width, and 9 feet in length. If concrete blocks 8 inches thick are used, the inside dimensions of the building as well as those of the tank will be changed somewhat to conform.

The foundation and walls may be built in accordance with the suggestions previously given for such work. The loading platform should

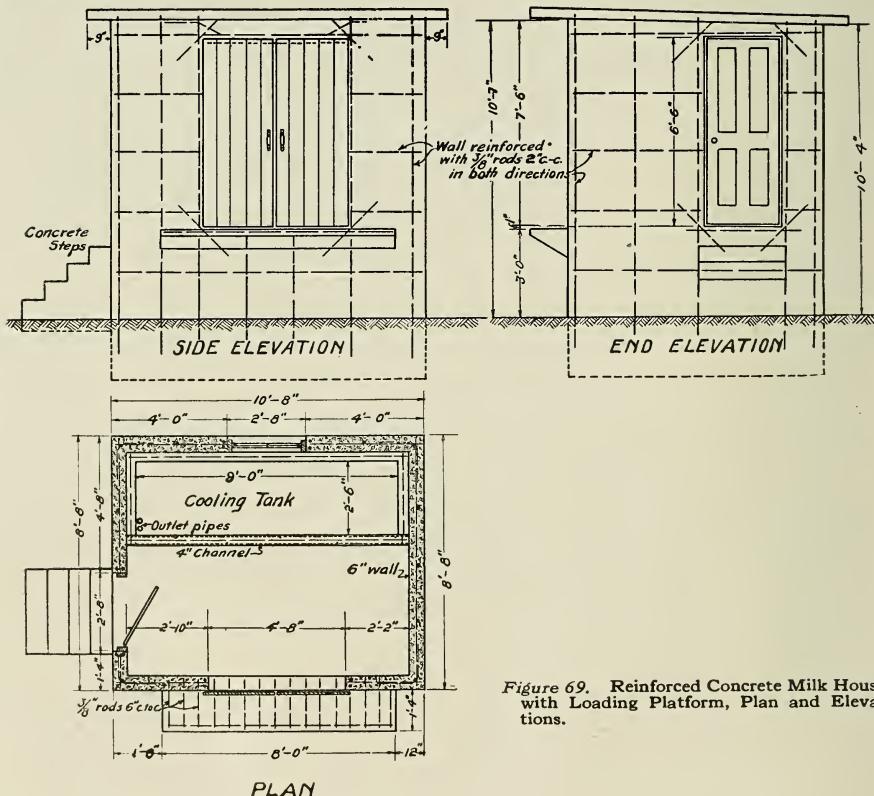


Figure 69. Reinforced Concrete Milk House with Loading Platform, Plan and Elevations.

extend out about 16 inches beyond the outside of the wall, and should be about 8 inches thick where it joins the wall, tapering to a thickness of 3 inches at the outer edge. The forms for the platform may be constructed easily of planks and hardly need detailed explanation. The reinforcing for the platform should consist of twelve $\frac{3}{8}$ -inch rods placed 6 inches apart, center to center, at right angles with the direction of the wall and three $\frac{3}{8}$ -inch rods parallel to the wall, placed as shown in the section diagram Figure 70, one rod being placed close to the edge of the platform and the other two in the wall as shown. The rods for the reinforcing at right angles with the wall should be 30 inches in length, so that they may be imbedded in the wall about 10 inches below the level of the platform. They should be brought up around the inside horizontal wall reinforcing rod, and then bent down to a horizontal position so as to extend to the edge of the platform. The horizontal portion of these rods should be placed an inch below the surface of the platform. If placed at a greater depth, the efficiency of the reinforcing will be decreased.

As a precaution against possible settling, the tank should rest on a concrete foundation. For this purpose lean concrete (Specification E, page 157), will suffice. This foundation should be high enough to bring the tank to the desired level, as indicated by the dimensions in the drawing.

The tank and floor should be constructed separately, after the walls are completed. Care should be taken before laying the floor to have the

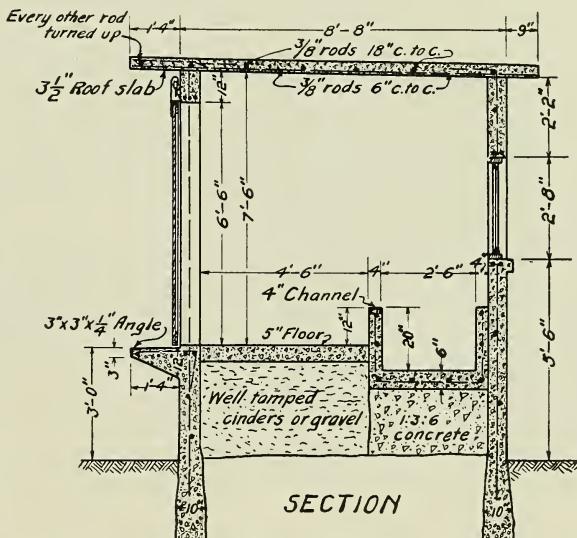


Figure 70. Reinforced Concrete Milk House with Loading Platform—Sectional View.

Table of Concreting Materials

	CONCRETE		CEMENT		SAND		GRAVEL	
	Cu. Yds.	Mixture	Bbls.	Sacks	Cu. Yds.	Cu. Ft.	Cu. Yds.	Cu. Ft.
Foundation.....	2.04	1:2 1/2:5	2.62	10.48	0.92	24.80	1.86	50.00
Floor and { Surface.....	0.17	1:2	0.51	2.04	0.15	4.10	.....	.....
Platform } Base.....	0.82	1:2 1/2:5	1.09	4.36	0.37	10.00	0.75	20.20
Walls.....	5.45	1:2:4	8.55	34.20	2.40	64.80	4.80	129.60
Tank.....	0.97	1:2:3	1.65	6.60	0.50	13.60	0.75	20.20
Steps.....	0.30	1:2 1/2:5	0.39	1.56	0.14	3.64	0.27	7.40
Roof.....	3.00	1:2:4	4.55	18.20	1.36	36.70	2.68	72.0

Total..... 12.75 Cu. Yds. 19.36 Bbls. 5.84 Cu. Yds. 11.11 Cu. Yds.

Approximate amount of Reinforcing required:

400 pounds of $\frac{3}{8}$ -inch round rod.

(Order about 10 per cent extra to allow for waste in cutting.)

cinder or gravel fill beneath it well compacted, and a small amount of water may be used, if necessary, to aid this operation.

Full directions for building the concrete roof will be found on pages 58 to 67.

Proportions (See page 157).

Foundation, body of floor and platform and steps, Specification D.

Walls and roof, Specification B.

Tank floor and walls, Specification A.

Surface coat for floor, platform and steps, 1:2 cement and sand mortar.

Concrete Block Milk House

THE concrete block milk house, shown in Figure 72, is designed to meet the conditions where a small house is desired, equipped with cooling tank, but without water supply tank or ice room. This structure is 10 feet 8 inches by 8 feet 8 inches in outside dimensions, and is made of standard 8 x 8 x 16-inch concrete block. The cooling tank is 2 feet 6 inches by 8 feet 8 inches in inside dimensions, and has a capacity of fourteen 14-inch cans.

The roof shown has a wooden frame, although a concrete roof built as directed on pages 58 to 67 would be preferable, the wood roof only being shown to illustrate the method of plastering the walls and ceiling. The wooden roof frame is covered with cement shingles or ready roofing, the former being superior to the latter because of their permanence and fire-resisting properties.

The inside walls of the building should be finished up smooth, preferably plastered. Metallic lath should be attached to the under side of the roof and the ceiling plastered up. The surface of the plaster should be made smooth, and all corners round, so that it may easily be



Figure 71. Dairy House of Wm. Stoll, Lansing, Michigan. Built of home made blocks made in a mold of Mr. Stoll's own manufacture.

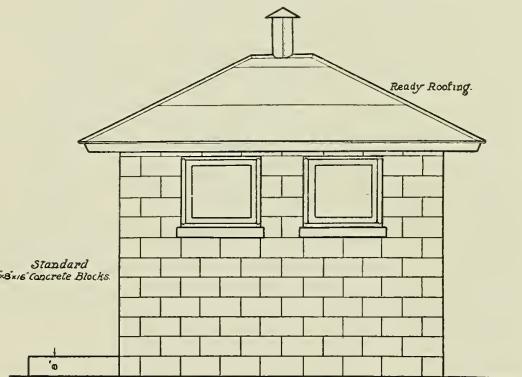
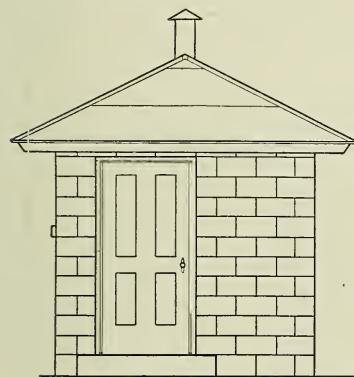
washed down and kept free from accumulating dirt. The cement plaster for use in interior work should consist of one part cement, $1\frac{1}{2}$ or 2 parts sand, with a possible addition of a small amount of thoroughly slacked lime, which will make the plaster easier to put on. The amount of lime added to the plaster should not exceed 5% of the whole. (See general directions on page 52). Directions for casting the window sills will be found on page 45.

Proportions (See page 157).

Footings, and body of platform and floor, Specification D.

Concrete block backing, Specification B.

Tank floor and walls, sides and lintels, Specification A.



-End Elevation-

-Elevation-

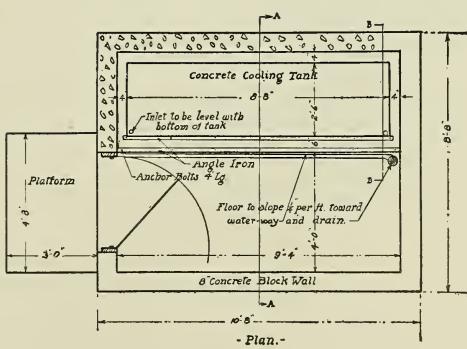
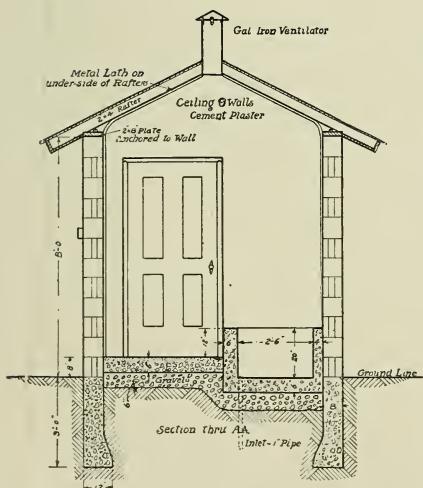


Figure 72. Small Concrete Block Milk House.

Table of Concreting Materials

	Cu. Yds. of Concrete	MIX-TURE	CEMENT		SAND		STONE	
			Bbls.	Sacks	Cu.Yds.	Cu.Ft.	Cu.Yds.	Cu.Ft.
Footings.....	3.3	1:2½:5	4.10	16.40	1.52	41.0	3.04	8.20
Walls (Block)*.....	270 Blks.	1:2:4	5.93	23.72	1.78	48.0	3.50	94.5
		1:2	1.43	5.72	.32	8.7	.....	.....
Mortar.....	5.25	1:2	16.90	67.60	5.00	135.0	.....	.....
Sills.....	.06	1:2:3	.09	.36	.03	.8	.05	1.35
Platform { Base.....	.30	1:2½:5	.37	1.48	.14	3.8	.28	7.56
Platform { Surface.....	.04	1:2	.13	.52	.04	1.1	.....	.....
Floor { Base.....	.58	1:2½:5	.72	2.88	.27	7.3	.54	14.60
Floor { Surface.....	.12	1:2	.38	1.52	.11	3.0	.....	.....
Tank.....	1.15	1:2:3	2.00	8.00	.60	16.2	.88	24.0

Total..... 32.05 Bbls. 9.81 Cu.Yds. 8.29 Cu.Yds.

*Body of Block 1:2:4 mixture.

Facing 1:2 cement and sand mortar.

Steel required for Tank:

24 $\frac{1}{4}$ -inch round rods 2 feet 2 inches long..... 52 Linear Feet
 17 $\frac{1}{4}$ -inch round rods 3 feet long..... 51 Linear Feet
 11 $\frac{1}{4}$ -inch round rods 9 feet 4 inches long..... 103 Linear Feet

Total..... 206 Linear Feet

Weight 35 Pounds

(A few feet additional should be ordered to allow for waste in cutting.)

Design for Standard Milk Cooling Tank

THE accompanying illustration shows a standard design for a milk cooling tank. It will be found convenient to construct all cooling tanks wide enough to accommodate two rows of cans. Where the standard 14-inch cans are used, this width should be about 2 feet 6 inches. The desired capacity is obtained by varying the length of the tank.

The design shown in Figure 73 possesses a number of advantages. The tank is arranged at a distance below the floor which allows the operator to lift the cans with ease by obtaining a maximum purchase at the point where the cans are hardest to raise—just as they are leaving the water. It is recommended that the floor of the tank be 8 inches below the floor of the milk room, and that the tank be made 20 inches in depth inside. The standard size milk cans, when resting on the bottom of the tank, will then be surrounded by water up to the neck of the cans, and the possibility of the water entering the cans will still be precluded.

The tank floor and walls should be concreted at one operation. The floor of the tank should be 6 inches thick and the walls 4 inches thick. Reinforcement should consist of $\frac{1}{4}$ -inch round rods spaced as shown in the illustration. Ten longitudinal rods are required, these

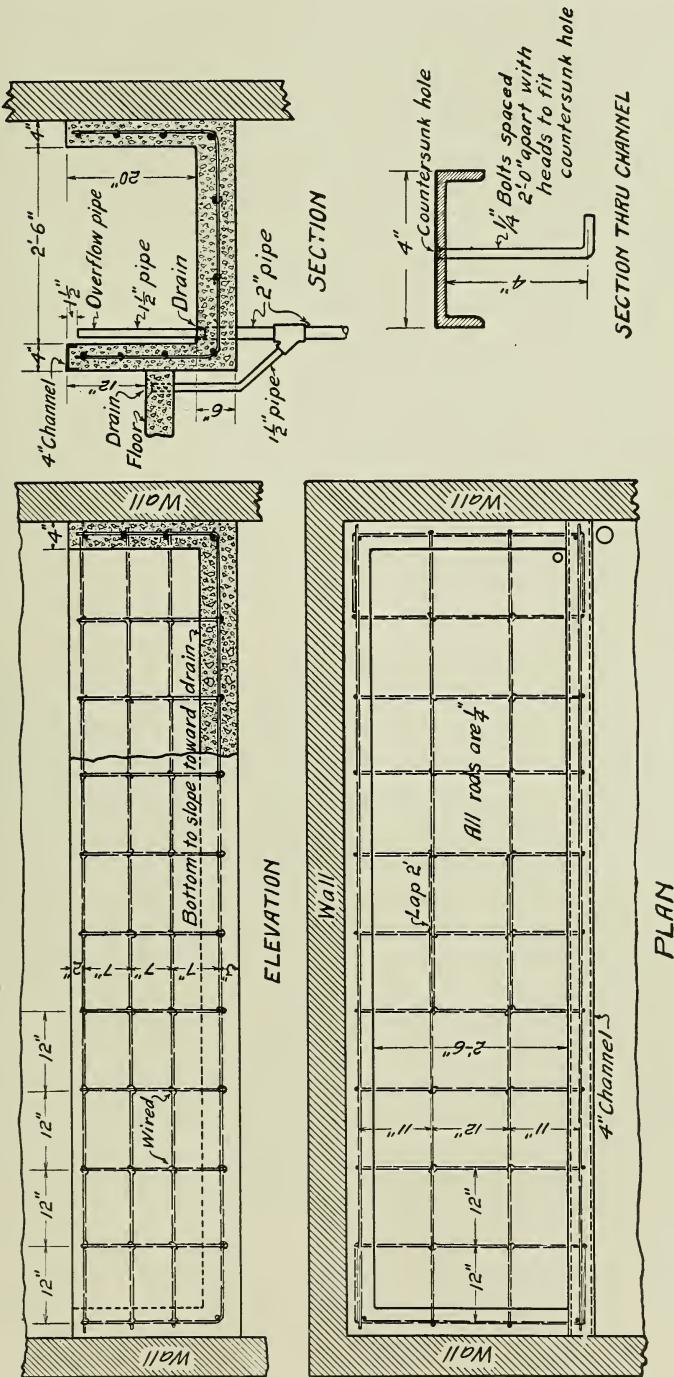


Figure 73. Plan of Standard Milk Cooling Tank.

being spaced 7 inches apart in the walls, and 11 or 12 inches apart in the floor. The crosswise reinforcing rods (which are bent up into a "U" shape as shown in the section) are spaced 12 inches apart. The longitudinal rods in the walls should extend around the tank as bands, care being taken to lap the ends of these rods for a distance of 24 inches. The reinforcing should be securely wired together at all intersections.

Concrete for the tank should be mixed in the proportion of 1 sack of cement, to 2 cubic feet of sand, to 3 cubic feet of screen gravel or stone, (Specification A, page 157), mixed with enough water to give it a "quaky" consistency. The top of the tank wall, over which the milk cans must be lifted, should be reinforced with a piece of 4-inch channel iron, anchored in the concrete by $\frac{1}{4}$ -inch bolts with heads counter-sunk in the channel, as shown in the section through channel. These bolts should be spaced about 2 feet apart.

Care should be taken before concreting to see that a firm base is provided. If the ground below the tank has been disturbed recently, or, if for any other reason, it is not firm, it should be packed down with the use of water, if necessary, and a 6-inch fill of cinders or gravel put in. Negligence in securing a good foundation for the tank occasionally causes trouble, as the settling of the ground beneath any portion of the tank will subject it to heavy strains.



Figure 74. Concrete Block Ice House on the farm of Mrs. Gallup, Rochester, Wisconsin. Built by J. A. Kilpatrick, Rochester. Size 14 feet square by 16 feet in height. Capacity, 90 tons. Cost, \$325. The ice is kept with minimum shrinkage, and the house will never warp out of shape.

Concrete Ice Houses

THE farm ice house is coming to be considered more of a necessity than a luxury. During the heat of the summer the souring of milk and the running of butter are not only an inconvenience, but in many cases mean the loss of considerable profit. Where ice is easily obtainable from lake or stream, the ice house is generally a saver of money on the dairy farm, not to mention the added convenience.

The first essential of a good ice house is insulation against heat. To insure this the walls and the floor and even the roof of the ice house are built so as to include one or more layers of an insulating material, and ventilators are provided in the roof to prevent the accumulation of warm air underneath. Mineral wool, charcoal, cork, felt, paper, sawdust, cinders and air which is confined, are the more common insulators. Insulating materials are always much more effective when dry than when wet, and for this reason it is important that the house be constructed of materials which will not allow moisture from the melting ice to reach the insulating material.

A wooden ice house is usually an unsightly structure after it has been up for a short time. It is generally warped and out of shape, and the sills and lower timbers decay rapidly from the dampness caused by the melting of the ice. Steel rods or struts used to brace such buildings make good conductors of heat from the outside with a resulting loss of ice through shrinkage. Insurance companies consider wooden ice houses



Figure 75. Concrete Block Ice House, Echo Valley Farm, Henry Hanson, proprietor, Odebolt, Iowa. Built in 1907 by the owner. Size, 16 feet by 24 feet.

poor fire risks, and buildings of this kind seem to be attractive objects for lightning.

A concrete ice house is a good investment because when once properly constructed it will last for an indefinite period and will not warp out of shape, blow down or be destroyed by fire. The additional expense of concrete construction, if there be any, will be entirely compensated during the first few years by the lower cost of up-keep and the freedom from repairs.

Capacity of the Farm Ice House. Solid ice weighs about 56 pounds per cubic foot and averages about 40 pounds per cubic foot, allowing for voids between cakes. On this basis a house 10 feet square and 10 feet in height would have a capacity of 20 tons, if carefully packed. This quantity will be found sufficient to take care of an average consumption of 500 to 700 pounds per week, for six months, allow-

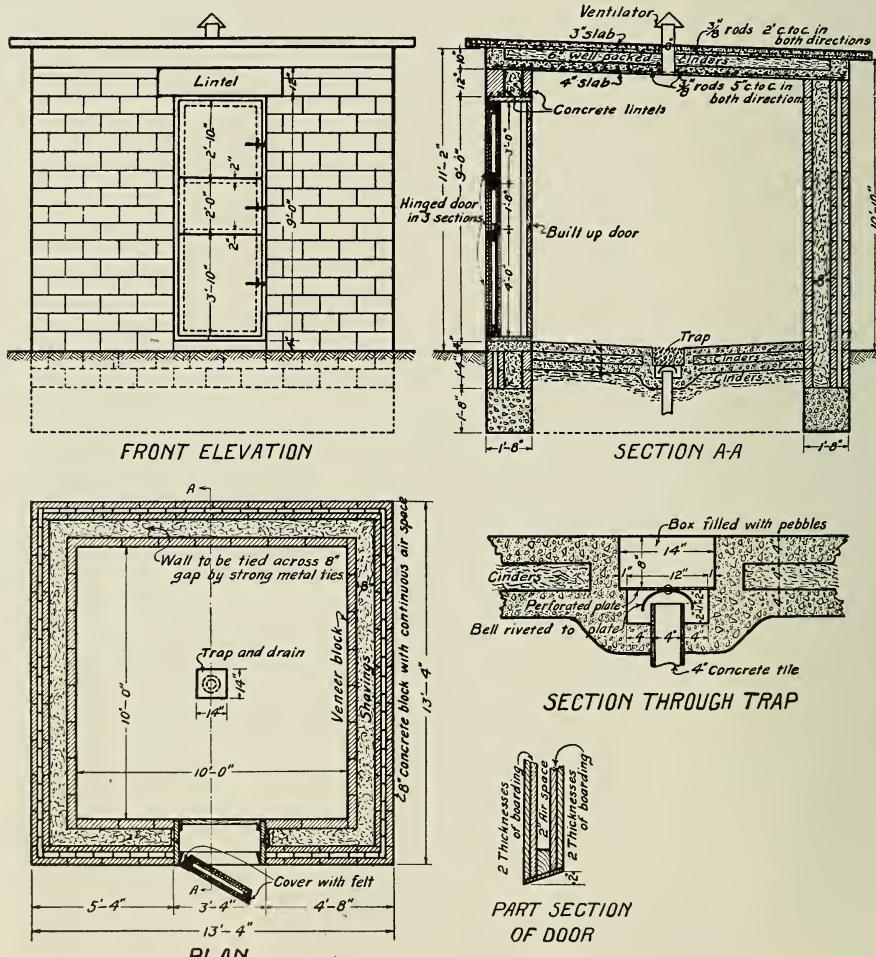


Figure 76. Concrete Block Ice House with double air space. A decidedly economical and practical structure.

ing liberally for shrinkage. Fifteen to twenty tons should be about the minimum capacity of the average farm ice house, and where plenty of cold water is not available for keeping the milk cool and for other purposes, it is advisable to build the ice house larger.

A Concrete Block Ice House

FIGURE 76 shows the design of a small concrete block ice house with walls having two air spaces. The inside of the building is 10 feet square by 10 feet in height and will hold from 15 to 20 tons of ice. The outer wall is constructed of hollow or air space concrete blocks and the inner wall of solid concrete veneer block. The floors and roof are also of concrete.

The foundation must go down below the frostline, and should extend up to within 16 inches of the ground line, at which point the first course of blocks should be started. The air spaces in the walls are thus brought down below the ground line, which insures better insulation against the heat than would be possible otherwise.

The walls have double air spaces and consist of an inner wall of solid veneer block 4 inches thick and an outer wall of 8-inch hollow block. There is an 8-inch air space within the two block walls. For maximum efficiency the hollow blocks should be of a continuous air space type similar to the Anchor block. The inner and outer walls must be tied together with metal ties made of strap iron or similar material at frequent intervals.

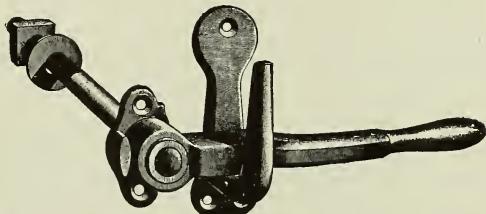


Figure 77. Common Clamp for closing ice house doors. A good clamp is very essential in keeping out air.

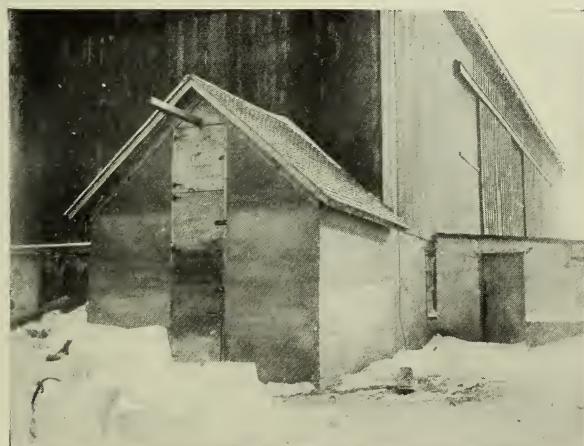


Figure 78. Monolithic Ice House of John Dowd, Grafton, Wisconsin. Size of ice room, 10 feet by 12 feet. Built by the owner.

Care must be taken to have the ties between the inner and outer walls extend only to the air space in the outer blocks, not continuing through to the outer surface, as steel is an excellent conductor of heat and cold and would readily conduct heat from the outside into the ice chamber. The space between the blocks may be filled with ground cork, dry shavings or sawdust, or left without filling.

Dry shavings probably make the cheapest and most satisfactory insulator. The joints between blocks should be well flushed in order to prevent the penetration of dampness, and a coating of tar or pitch on the side of the wall next to the insulating material is a good safeguard.

For the floor, the dirt should be excavated to a depth of a foot or more, if necessary to reach firm soil. Cinders should then be filled in and well packed, up to within 8 inches of the ground line. Two 4-inch layers of concrete are placed on this with an intermediate layer of cinders between, as shown in the figure. The floor should slope toward the drain in the center. The trap in the drain is necessary to prevent the circulation of air up through the ice. The design shown is simple and efficient, and no part of it will rust except the plate and the bell, which are both removable. The box opening is made with a wooden box form, and a 4-inch concrete tile should project about 3 inches through the center of the bottom. The plate, which is 14 inches square, permits the water to pass through. A bell, which hangs over the top of the tile when in position, is riveted to the center of the plate. Water will then

stand in the box to the level of the top of the tile, effectually sealing the drain. The space above the plate is to be filled with pebbles or broken stone.

The roof consists of two concrete slabs with a layer of cinders between. The lower slab is designed to carry the load, being 4 inches thick and reinforced with $\frac{3}{8}$ -inch round rods spaced 5 inches apart, center to center, in both directions.

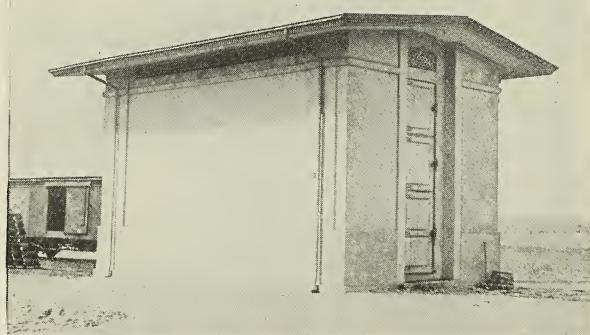


Figure 79. Ice House with Concrete Roof, Armour Farm, Lake Forest, Ill. A practical structure of pleasing appearance and permanent construction.

After the concrete has hardened sufficiently, 6 inches of cinders are placed upon it and covered with a 3-inch concrete slab reinforced with $\frac{3}{8}$ -inch round rods spaced 24 inches apart, center to center, in both directions. A 6-inch galvanized iron ventilator should be placed in the center of the roof as shown.

Two doors are provided. The inner one is built up similar to a silo door and the sawdust and ice piled against it during filling. The outer one is built in three sections, each made up of a 2-inch skeleton frame covered on both sides with two thicknesses of tongue-and-grooved boards with tarred paper between. The edges should be covered with felt to insure a tight joint. The middle section opens first, and then either the upper or lower section as desired. This makes it unnecessary to open the door to its full height at one time, thus protecting the interior as much as possible from warm drafts.

While the ice above is being used, the space between the lower sectional door and the inner door may remain filled with shavings. Each door must have a latch of a type that will press the door inward in locking it. The type of latch shown in Figure 77, is recommended for this purpose.

Proportions (See page 157).

Foundation, Specification D.

Floor, veneer blocks, backing for hollow blocks and roof, Specification B.

Lintels, Specification A.

Facing for hollow blocks, 1:2 cement and sand mortar.

Table of Materials

	MIX-TURE	CEMENT		SAND		STONE	
		Bbls.	Sacks	Cu.Yds.	Cu.Ft.	Cu.Yds.	Cu.Ft.
Foundation.....	1:2½:5	6.18	24.72	2.18	58.8	4.36	117.6
Floor.....	1:2:4	3.84	15.36	1.07	28.9	2.15	58.0
Hollow Blocks { Backing.....	1:2:4	14.32	57.28	4.02	108.3	8.03	216.6
Facing.....	1:2	2.95	11.80	0.83	22.2	.....	.....
Veneer Blocks.....	1:2:4	8.45	33.80	2.37	64.0	4.74	128.0
Roof.....	1:2:4	7.21	28.84	2.02	59.5	4.04	109.0
Lintels.....	1:2:3	.20	.80	.06	1.62	.12	3.24
Total.....		43.15	Bbls. 12.55 Cu.Yds. 23.44 Cu.Yds.				

Approximate amount of Reinforcing required:

450 Pounds (1200 feet) $\frac{3}{8}$ -inch round rods.



Figure 80. Concrete Block Poultry House, Echo Valley Farm, Odebolt, Iowa. A comfortable house, in which the fowls lay all year around. Dimensions, 16 feet by 36 feet. Built by the owner in 1907.

Concrete Poultry Houses

WHETHER raising a few chickens for table use, or running an extensive poultry farm, there is generally a good margin of profit in poultry. The profit, however, varies in amount according to the favorable or unfavorable circumstances under which the fowls are raised and marketed. Briefly, poultry profits depend upon the following essentials:

- (1) Suitable buildings, properly located.
- (2) Careful feeding and breeding.
- (3) Ability to hatch and rear chickens.
- (4) Availability of markets.

In the present chapter only the first of the above requisites will be dealt with, discussion on the other three being not only outside the scope of this booklet, but covered in a complete and comprehensive manner in various Experiment Station bulletins.

Location of the Poultry House. The poultry house should be located on ground that is either naturally dry, or provided with good artificial drainage. The location of the house should be on a rise of ground, if possible, providing south exposure to insure plenty of sunlight. Buildings which face the south get the largest exposure to the sun's rays, and are warmer, dryer and more cheerful than buildings not so located. An eastern exposure is preferable to a western exposure, as hens prefer morning to afternoon sun.



Figure 81. Poultry House of H. Cox, Farmer City, Illinois, constructed of home made concrete blocks. Dimensions, 20 feet by 40 feet. Cost about \$110.

The poultry house should be located, of course, with a view to saving time and labor in caring for the birds. Where a large number of fowls must be fed three times and watered once each day, and the house cleaned once daily, it need not be stated that the saving of even a few steps, by convenient location, results in no small saving of labor in the course of a year.

Requirements of a Good Poultry House. The two great requisites of a good poultry house are plenty of sunlight and an abundance of pure air. As a rule, poultry houses lack sufficient ventilation, which is far more important than warmth. Plenty of air insures the health of the poultry, but the arrangements of door and windows must always be such that drafts will be avoided, particularly in the vicinity of the roosts. Dampness in poultry houses, especially during cold weather, is generally the result of insufficient ventilation.

Sunlight is a great dispeller of disease, and the value of sufficient window area in poultry houses cannot be overestimated. It must be remembered, however, that while a house without plenty of sunlight is liable to be damp and dreary, a house containing excessive glass will be hot during summer days and extremely cold during winter nights.

Securing Proper Light and Ventilation. The best method of securing proper light and ventilation is by the combined use of cloth and glass windows. Roof or wall ventilators may also be used in conjunction, if desired. About one square foot of window area to ten square feet of floor area, about equally divided between cloth and glass windows, will be sufficient to give good light and ventilation if properly placed. In Bulletin No. 215 by the Wisconsin Agricultural Experiment



Figure 82. Monolithic Poultry House and Shop on the farm of Dr. D. S. Jaffray, Lisle, Illinois. One of several concrete buildings on Dr. Jaffray's place.

Station, Professors Halpin and Ocock give the proper amount of window space as one square foot of glass to fourteen or sixteen square feet of floor space, and the amount of cloth as one square foot to eight or ten square feet of floor space. Professors Rice and Rogers, in Bulletin No. 274, by Cornell University, recommend one square foot of glass surface for about 16 feet of floor area where the windows are properly placed, and used in conjunction with some other means of ventilating.

The same bulletin says: "The time when sunshine is most needed is when the sun is lowest, from September 21st to March 21st. Figure 83 shows the extreme points which the sunshine reaches during this period, through a four foot window placed with the top 4 feet, 6 feet and 7 feet high, respectively. With the highest point of the window at 4 feet, the direct sun's rays would never reach farther back than 9 feet; at 6 feet it would shine 13½ feet back, and at 7 feet it would strike the back side of the house a little above the floor. In very narrow houses

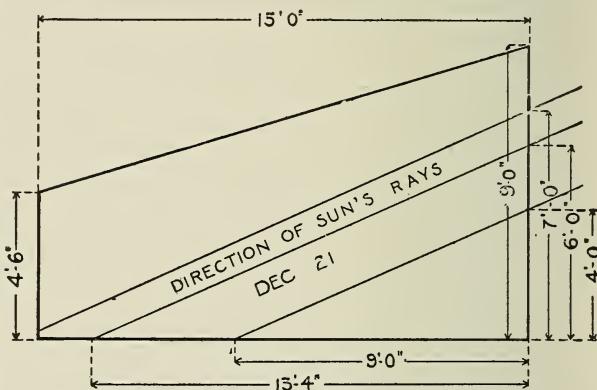


Figure 83. Diagram showing direction of sun's rays December 21, and distance back which rays will penetrate for various heights of windows.



Figure 84. Reinforced Monolithic Poultry House of the Burn Brae Hospital, Primos, Pennsylvania. Built by the Superintendent, Dr. Stanton. Dimensions, 15 feet by 30 feet. Cost, \$300. Dr. Stanton is so well pleased with this building that five more similar structures will be put up by the Hospital this year.

a window not higher than four feet above the floor would suffice. In houses deeper than 15 feet, however, the window should be placed even higher than seven feet in order to obtain the most desirable conditions.

Small glass in window-sash seriously obstructs the light. Very large lights break too easily and are expensive. Eight by ten is a good sized glass to be used in a 12-inch light sash, making it about 3 feet 9 inches high by 2 feet 5 inches wide."

Cleanliness and Convenience. The poultry house should be built in such a manner that it may be cleaned out easily and disinfected. The inside surface of the walls should be made smooth and free from ledges, projections or pockets. If care is taken with either concrete block or monolithic work, smooth walls will result without plastering. Litter accumulates rapidly and is hard to remove from square corners, and for this reason it is advisable to make all corners round, using the method shown in Figure 29, page 34. The windows should be placed where they will be protected and remain as free as possible from accumulations of litter.

Size of Building. Regarding the size of house to build, Wisconsin Bulletin No. 215 says "In determining the size of a house, consider the number of fowls that are to be kept in one pen. A flock of fifty hens should usually be allowed about five square feet of floor space per hen. Where the attendant is careful to keep the house clean and the floor heavily littered with straw, less floor space will be necessary. As a rule, it is far better to allow too much floor space than too little. The larger the pen, the less floor space will be required per hen. One hundred hens will thrive in a pen 20 x 20 feet, that is, four square feet of floor



Figure 85. Concrete Poultry and Hog Houses, O'Neil Dairy Farm, Thiensville, Wisconsin. These buildings, which are of monolithic construction, are placed at a distance from the other structures and have excellent provision for light and ventilation.

space per hen, but one hen will not thrive in a pen 2 x 2 feet. In the large pen, each one has a chance to wander about over the entire floor space, thus getting more exercise. As the number in the flock becomes less, the amount of floor space per hen must increase, and anyone keeping eight or ten hens should allow at least ten square feet of floor space per hen, unless he is prepared to give special attention to cleaning and bedding the house. A crowded condition in a poultry house is responsible for lack of winter egg production."

Cornell Bulletin No. 274 says, "The best net results appear to be secured when fowls are allowed four or five square feet floor space each. Small flocks lay better than large flocks. While ordinarily we may expect to get more eggs from a small flock than from a large one it is also true that every time we double a flock we divide the labor. Fifty to one hundred fowls seem to be about as many as it is safe and economical to keep together in one pen as a unit."

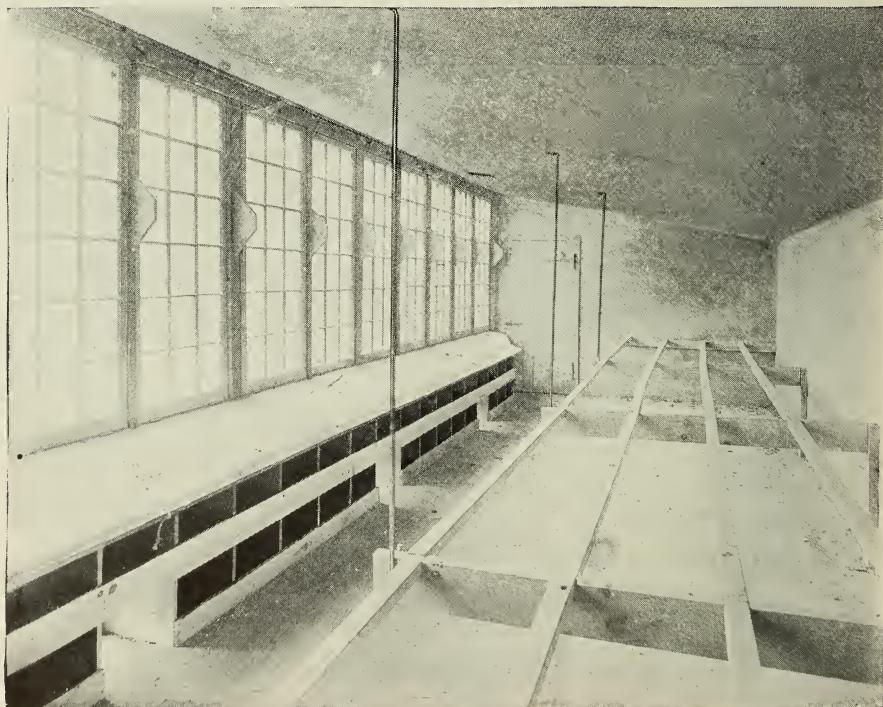


Figure 86. Interior of Concrete Poultry House, O'Neil Dairy Farm, Thiensville, Wisconsin. Notice the light, sanitary construction, and the absence in the walls of cracks which harbor lice and mites.

Reinforced Concrete Poultry House for Several Flocks

THE monolithic house shown in Figure 88, may be built with as few or as many sections as desired to accommodate any number of flocks. As shown, this poultry house will furnish quarters for five flocks of about 35 birds each. The poultry compartments each consist of a room 9 feet 8 inches wide and 12 feet long, with a scratching pen of the same width and 6 feet long on the south side. The scratching pen is designed with a low roof with large glass windows on top making it warm and light and providing an excellent place for the chickens to scratch and pick up their food during cold and disagreeable weather.

The passageway is 3 feet 8 inches in width and runs the entire length of the building. Windows 2 feet 8 inches square are provided to furnish light, as in the preceding design. Details of the poultry room windows are shown in Figure 88, and Figure 89, section A-A. The window openings on the front side of the poultry room above the scratching pen roof are 2 feet 8 inches high and 3 feet 8 inches in length, and two are provided for each compartment. The openings in the scratching pen roof are 2 feet 8 inches by 4 feet 6 inches. Those on the front side of the scratching pen are 1 foot 10 inches by 3 feet 4 inches.

All of the windows excepting those on the front side of the scratching pens are of glass. Hot bed sashes with the glass put on in a manner similar to the shingles on a roof are the best to use over the openings in the roof of the scratching pen. Small windows below are made of muslin or canvas and serve as doorways for the chickens. The roosts and nests should be constructed as shown in the detailed construction (Section A-A) and described on pages 114 to 116.

In building the structure the walls may be run up simultaneously with a saving of a great deal of time, but less form lumber will be required if the various walls are built independently. The sidewalls are all identical in construction and one form will suffice for all. While the side walls are being built, one at a time, the back wall and the low front wall may be built. It is preferable to concrete the back wall at



Figure 87. Concrete Chicken House of W. F. Wickham, Pleasant View Poultry Farm, Center Point, Iowa.

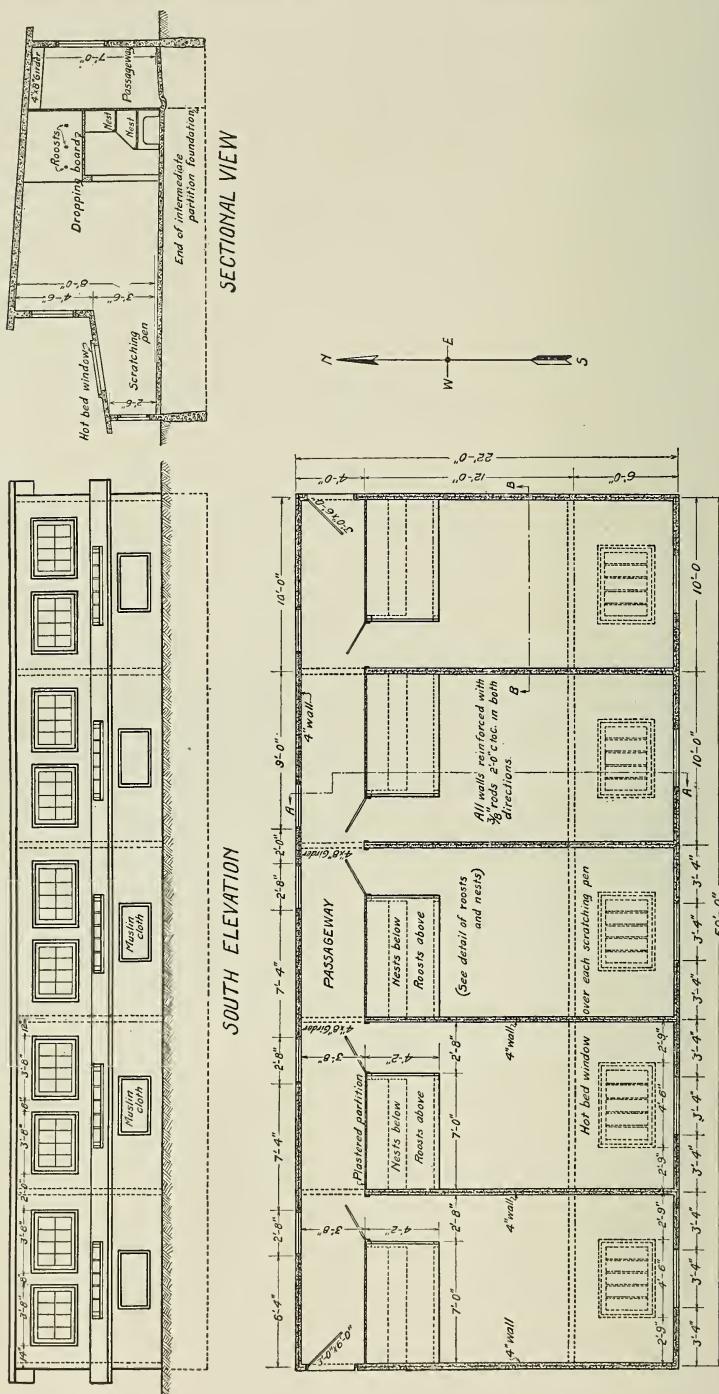


Figure 88 Reinforced Concrete Poultry House designed to accommodate several flocks. A fire-proof and vermin-proof structure of the most approved type.

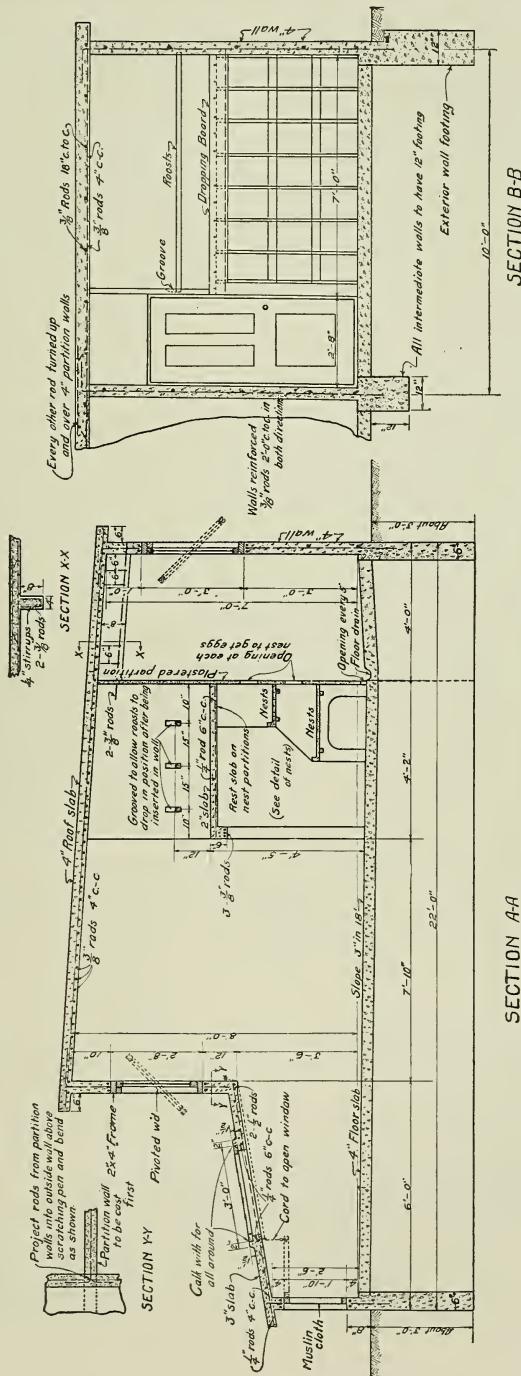


Figure 89. Sectional Views, Reinforced Concrete Poultry House.

one operation, but if this is impossible it may be built in sections taking care to secure a good bond between the old and the new concrete wherever the work has been discontinued. The method of joining old work to new is described on page 36.

In completing the side walls and the back wall the reinforced girders spanning the passageway should be cast in place. These girders are 8 inches deep, 4 inches wide, and 4 feet 4 inches long, and require only a simple box mold. The girders should be reinforced with two $\frac{3}{8}$ -inch rods placed one inch above the bottom, and four $\frac{1}{4}$ -inch stirrups placed as shown in section A-A and section X-X, Figure 89. The $\frac{3}{8}$ -inch reinforcing rods should be long enough to be securely anchored in the concrete at both ends of the girder. When these girders are placed in the walls the tops should be flush with the top of the walls. All of the walls should be reinforced according to the standard reinforcing directions given on pages 39 to 44, with the modifications shown in the figures.

Vertical reinforcing rods in the walls should extend about 6 inches above the top of the wall for the purpose of joining the roof reinforcing. If the end walls are not constructed at the same time as the side walls, corner reinforcing should be placed in the side walls so as to extend into the end walls when they are concreted later.

The construction of the building will be found more simple if the scratching pen roof and the front wall above it are left until the completion of all the other walls. Forms for the scratching pen roof should only consist of a tight floor of boards, a suitable wooden frame for making the opening in the top of the roof, and a small mold box for casting the eave. The wall above the scratching pen roof requires only a simple wall form with frames in it to produce the desired window openings. The most economical manner of casting this roof wall is to provide a form for just one section and to take down the form and move it to the next section as the section previously concreted becomes strong enough to warrant removal of the forms.

If this method be used, the lengthwise reinforcing should not be discontinued at the end of each section, but should run continuously from one end of the roof to the other, the roof only being broken where



Figure 90. Concrete Poultry House on the 5-acre poultry farm of Karl Selig, Downer's Grove, Illinois. Each of the two wings of the house have quarters for five flocks. The center portion of the building is occupied by the owner.

necessary, and there lapped in accordance with the suggestion made on page 140. The roof slab is 3 inches thick and is reinforced with $\frac{1}{4}$ -inch rods spaced 6 inches apart, center to center, the entire section of the roof; and $\frac{1}{4}$ -inch rods spaced 4 inches apart, center to center, the short way of it. These rods should be wired together and placed in the roof in accordance with suggestions on page 65.

The wall above this roof should be 4 inches thick, reinforced as shown in section A-A, Figure 89, with two $\frac{1}{2}$ -inch rods running lengthwise of the wall one inch above the bottom of it, and with corner reinforcing extending up from the scratching pen roof and extending from the wall into the main roof above. Additional reinforcing should be placed around the windows as suggested on page 41. Section Y-Y shows the method of joining this wall to the partition walls.

The main roof of the house should be constructed in accordance with the suggestions furnished in the section on roofs, and the forms shown in Figure 52 will be found suitable for use in this case. Reinforcing consists of $\frac{3}{8}$ -inch rods placed 4 inches apart, center to center, the long way of the roof, and $\frac{3}{8}$ -inch rods spaced 18 inches apart, center to center, the short way of the roof. Although this roof may be constructed in sections in the same manner as that suggested for the small roof below, the reinforcing should be continuous from one end of the roof to the other. Great care must be taken in joining one section of the roof to the other to obtain a good bond between the old and new concrete. (See page 65.) Care should be taken to discontinue roof slabs directly over the center line of the partition walls which support it.

Proportions (See page 157).

Foundations, footings and walls, Specification D.

Floor, Specification C.

Roof girders and slabs, Specification B.

Table of Materials

	MIX-TURE	ONE ROOM				EACH ADDITIONAL ROOM			
		Concrete Cu. Yds	Cement Bbls.	Sand Cu. Yds.	Stone Cu. Yds.	Concrete Cu. Yds	Cement Bbls.	Sand Cu. Yds.	Stone Cu. Yds.
Footings and Foundations.....	1:2 $\frac{1}{2}$:5	6.04	7.85	2.78	5.56	3.33	4.33	1.53	3.06
Walls.....	1:2 $\frac{1}{2}$:5	4.02	5.22	1.85	3.70	2.58	3.36	1.19	2.38
Roof Slabs.....	1:2:4	2.94	4.62	1.29	2.59	2.75	4.32	1.21	2.42
Floor.....	1:2 $\frac{1}{2}$:4	2.55	3.72	1.30	2.09	2.55	3.72	1.30	2.09
Girders.....	1:2:4	.03	.05	.01	.03	.03	.05	.01	.03
Totals.....			21.46	7.23	13.97		15.78	5.24	9.98
			Bbls.	Cu. Yds.	Cu. Yds.		Bbls.	Cu. Yds.	Cu. Yds.

Approximate amount of Reinforcing required:

FOR ONE ROOM

1485 feet $\frac{3}{8}$ -inch rods..... Weight 558 Lbs.
283 feet $\frac{1}{4}$ -inch rods..... Weight 48 Lbs.
Total. 606 Lbs.

FOR EACH ADDITIONAL ROOM

1248 feet $\frac{3}{8}$ -inch rods..... Weight 468 Lbs.
290 feet $\frac{1}{4}$ -inch rods..... Weight 50 Lbs.
20 feet $\frac{1}{2}$ -inch rods..... Weight 14 Lbs.
Total. 532 Lbs.

(Add 10 per cent additional to allow for waste.)

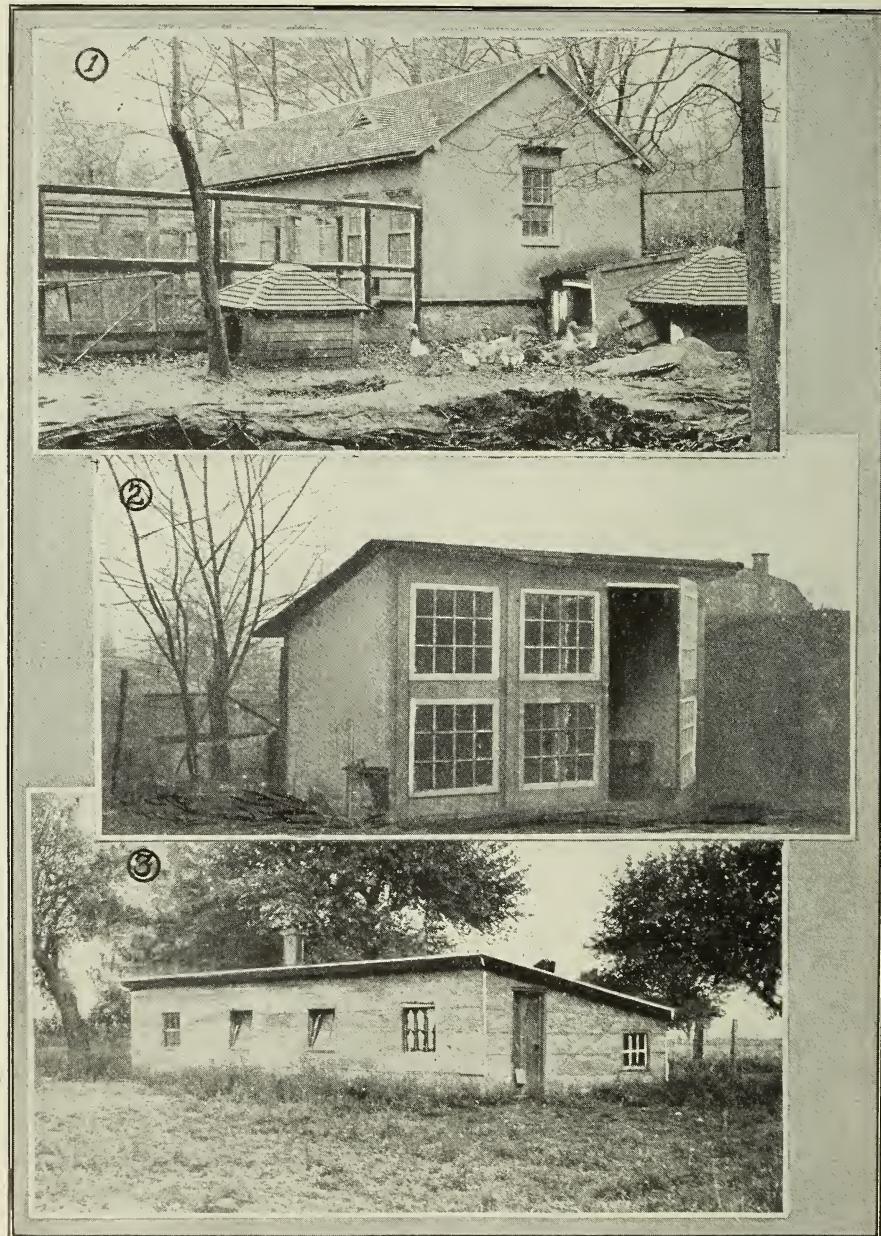


Figure 91. CONCRETE POULTRY HOUSES

- (1) Cement Plaster Poultry House of W. D. Dengre, West Manchester, Mass.
- (2) Concrete Poultry House of R. E. Griffith, Haverford, Pa.
- (3) Dr. N. Baldwin's Concrete Poultry House, Coldwater, Michigan.

Concrete Block Poultry House

IN putting up a poultry house the owner frequently has in mind future additions or alterations to give the house greater capacity. The concrete block building shown in Figure 93 is designed to accommodate a flock of thirty-five or forty chickens, but is so planned that it may be enlarged to accommodate any number of birds desired, by simply adding additional rooms of the same size onto either side of the structure.

The poultry compartment is 11 feet 8 inches from the hallway to the front, and 12 feet 4 inches from side to side. The hallway is divided off from the poultry compartment by a cement plaster wall, directions for the building of which will be found on pages 52 to 57. Light and ventilation are provided in the poultry compartment by a large window in the front, 6 feet 8 inches in height and 5 feet 4 inches in width. The window which should swing on a vertical axis or from hinges attached to the top of the frame, should be covered with heavy muslin or light canvas.

Two doors are shown leading into the house from the outside, but only one is required if just a single section of the house is built. If more than one section is built it is convenient to have a door at each end of the hallway. It is also necessary to provide a door between the hallway and the poultry room, although none is shown in the figure. Light is provided in the hallway by a glass window 2 feet 8 inches square, for each section of the house.

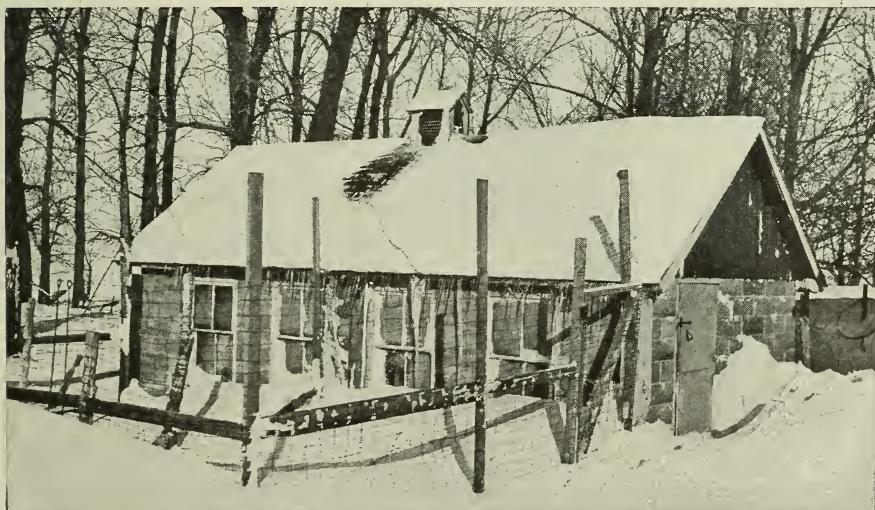


Figure 92. George Rosenhauer's Poultry House, Early, Iowa. In spite of outside cold the fowls are kept in good condition and lay all winter.

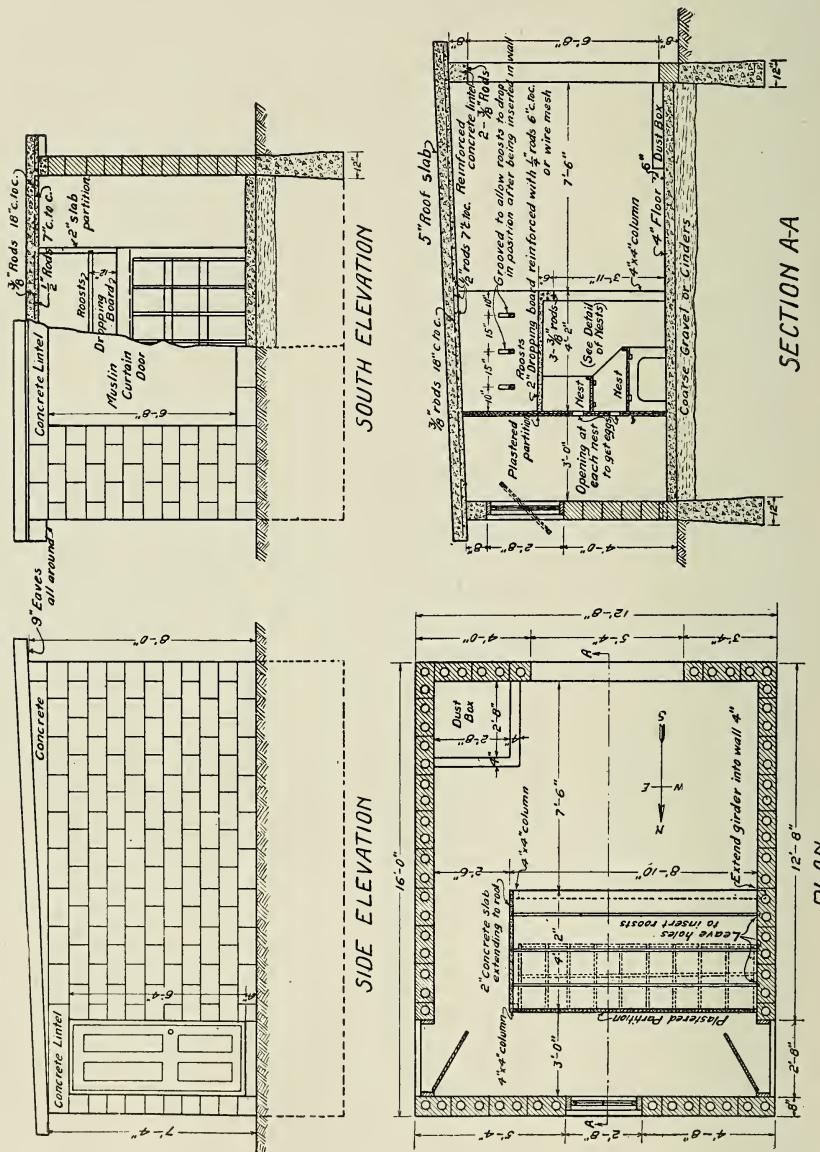


Figure 93. Concrete Block Poultry House which may be enlarged to accommodate additional flocks by duplicating the structure as shown.

The foundations, floor, walls and roof of the house may be constructed in accordance with the design shown in the figure and the general directions for such work given in the first section of this book. The roof slab is 5 inches thick, reinforced with $\frac{1}{2}$ -inch round rods, spaced 7 inches apart from side wall to side wall, and $\frac{3}{8}$ -inch round rods 18 inches apart from front to back. The $\frac{1}{2}$ -inch rods should be placed 1 inch above the bottom of the slab, and the $\frac{3}{8}$ -inch rods laid on top of, and wired to them. The lintel above the window opening on the front side of the house should be 6 feet 8 inches in length, reinforced with two $\frac{3}{8}$ -inch round rods placed one inch above the bottom of the lintel.

The concrete roosts, nests, and dust box should be constructed as suggested under the head of "Interior Fittings of Poultry Houses," pages 113 to 116. Openings are left in the cement plaster partition between the hallway and the poultry compartment through which to gather the eggs without entering the room with the poultry. These openings may be covered with a wooden or screen door, or a number of individual doors, to prevent the hens from coming out through them.

Proportions (See page 157.)

Footings, Specification D.

Body of Blocks and Single Course Floor, Specification D.

Roof, Specification B.

Lintels, Specification H.

Plaster Partition and Surface Coat for Concrete Blocks, 1:2 cement and sand mortar.

Table of Materials

	VOL. Cu. Yds	MIX- TURE	CEMENT Bbls.	SACKS	SAND Cu.Yds. Cu.Ft.	STONE Cu.Yds. Cu.Ft.
Footings.....	5.18	1:2 $\frac{1}{2}$:5	6.42	25.68	2.40 64.80	4.77 128.80
Blocks { Body.....	....	1:2 $\frac{1}{2}$:4	7.34	29.36	2.70 73.00	4.32 116.60
Surface.....	....	1:2	1.55	6.20	.46 12.42	.... ....
Lintels.....	.31	1:2:3	.54	2.16	.16 4.32	.24 6.50
Roof.....	3.85	1:2:4	5.82	23.28	1.74 47.00	3.43 9.28
Plaster Partition.....	.42	1:2	1.30	5.20	.39 10.54	.... ....
Floor.....	2.06	1:2 $\frac{1}{2}$:4	2.86	11.44	1.05 28.30	1.69 45.60

Total..... 25.83 Bbls. 8.90 Cu.Yds. 14.45 Cu.Yds.

Approximate amount of Reinforcing required:

650 feet $\frac{3}{8}$ -inch round rod..... Weight 245 Lbs.

(Add about 10 per cent additional to allow for waste.)

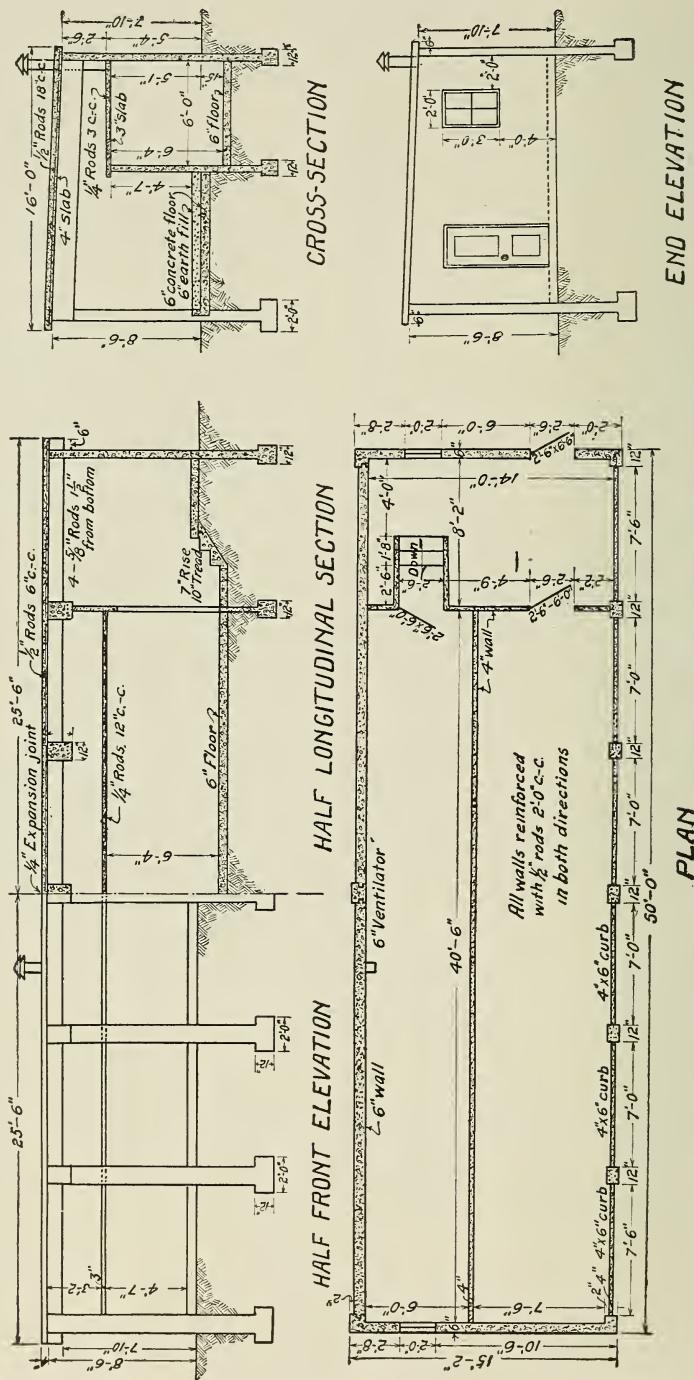


Figure 94. Reinforced Concrete Poultry House with Incubator Cellars, designed for I. S. Hamilton, West Bridgewater, Pennsylvania.

Reinforced Concrete Poultry House with Incubator Cellar

AN incubator cellar is frequently a desirable adjunct to the poultry house, and where it is desired to provide space for the incubators in the same building in which the poultry is housed, the design shown in Figure 94 will be found convenient. This building was designed for F. S. Hamilton, West Bridgewater, Pa., from suggestions furnished by him. It has a poultry compartment 7 feet 6 inches in width and 40 feet 6 inches in length, with a loft on one side 6 feet in width and extending the entire length of the poultry compartment.

The roosts may be placed in the loft. The incubator room is three steps below the floor of the poultry room, and is 6 feet in width and 40 feet 6 inches in length. A vestibule or storeroom 14 feet by 8 feet 2 inches is provided at the end of the building with doors leading to both compartments. One side of the poultry room is open, the roof of the structure being supported on the open side by columns. The openings between columns should be provided with muslin or canvas curtains which can be lowered to give sufficient warmth during cold weather.

A low curb should be built between the columns on the open side of the poultry room to prevent the dirt on the floor from being scratched out. The method of construction and dimensions of this curb are given in Figure 94.

The footings for the walls are 12 inches wide, and those for the columns are 18 inches wide. The walls of the structure are 6 inches thick and extend around three sides. A 4-inch concrete panel wall 7 feet 6 inches long extends between the two columns at the right end of the structure, forming the fourth side of the feed room. The columns which support the roof on the fourth side are 8 inches by 12 inches in section and are reinforced with four $\frac{1}{2}$ -inch round rods placed $1\frac{1}{2}$ inches in from the corners of the columns. These columns support the



Figure 95. Home of A. L. Larson's prize flock, near Aberdeen, South Dakota. R. K. Hafss, Contractor.

roof girders which in turn support the roof slabs. The wall on the long side of the building is broken into two panels between which is placed a column slotted as shown in the illustration. This column is added for the sake of appearance only, and if it is desired to omit the column an expansion joint should be left at this point as directed on page 36. The end walls are tongued to the back wall as shown. The slab above the incubator cellar is 3 inches in thickness and is reinforced with $\frac{1}{4}$ -inch rods spaced 3 inches, center to center, across the short way of the slab, and about 24 inches, center to center, lengthwise of the slab. Forms for the slab should be constructed at the same time as those for the walls, and the slab and walls, up to the slab, concreted at the same time. The back wall of the building may then be carried up to the roof line.

If the roosts are placed in the loft above the cellar roof, the roof slab will serve as a dropping board. The roof girders are 12 inches wide and 16 inches deep, reinforced with four $\frac{5}{8}$ -inch rods placed $1\frac{1}{2}$ inches back from the corners as shown. They are cast in place in mold boxes at the same time as the roof slabs.

Proportions (See page 157).

Foundations and Column Footings, Specification D.

Floors, Curbs, Stairs, Walls, Partitions, Columns, Beams and Roof, Specification B.

Table of Materials

	Cu. Yds.	MIX-TURE	CEMENT		SAND		STONE	
			Bbls.	Sacks	Cu.Yds.	Cu.Ft.	Cu.Yds.	Cu.Ft.
Foundation.....	9.15	1:2 $\frac{1}{2}$:5	11 89	47 56	4.21	113.60	8.42	227.00
Column Footings.....	1.49	1:2 $\frac{1}{2}$:5	1.94	7.76	0.69	18.50	1.38	37.00
Floor.....	12.54	1:2:4	19.70	78.80	5.53	149.30	11.06	298.50
Curb.....	0.25	1:2:4	0.39	1.56	0.11	2.97	0.22	5.94
Stairs.....	0.11	1:2:4	0.18	0.72	0.05	1.35	0.10	2.70
Walls.....	13.15	1:2:4	20.65	82.60	5.78	156.20	11.56	312.40
Partitions.....	4.02	1:2:4	6.31	25.24	1.77	47.75	3.54	95.50
Columns.....	0.91	1:2:4	1.43	5.72	0.40	10.79	0.80	21.58
Beams.....	4.22	1:2:4	6.62	26.48	1.86	50.02	3.92	100.04
Cellar Roof.....	2.44	1:2:4	3.83	15.32	1.07	28.95	2.15	57.90
Roof.....	10.01	1:2:4	15.85	63.40	4.45	120.00	8.89	240.00

Total. 88.79 Bbls. 25.92 Cu.Yds. 52.04 Cu.Yds.

Approximate amount of Reinforcing required:

3140 feet $\frac{1}{2}$ -inch rods.....	Weight 2094 Lbs.
511 feet $\frac{5}{8}$ -inch rods.....	Weight 192 Lbs.
1318 feet $\frac{1}{4}$ -inch rods.....	Weight 220 Lbs.
340 feet $\frac{5}{8}$ -inch rods.....	Weight 355 Lbs.

Total..... 2861 Lbs.

Interior Fittings for Concrete Poultry Houses

Floors. A concrete floor is a very desirable feature in a poultry house, being durable and rat-proof, and easy to keep clean. The floor may conveniently be laid as soon as the foundation is in place, following closely the directions given in the section on "Concrete Floors," pages 23 to 26. The floor should be placed at a sufficient height above the level of the ground to prevent water from running in, and the surface should be troweled quite smooth, to facilitate cleaning.

The concrete poultry house floor should never be left bare, but should be covered with about three inches of sand or soft dirt. This should be replaced as often as necessary to keep it fresh and clean at all times. The sand should be covered with six to ten inches of straw in the winter. Besides providing warmth for the fowls, the straw makes it necessary for them to scratch harder for their feed, giving them needed exercise during cold weather.

Sand Bath. If it is impossible to secure sand in sufficient quantity to use on the entire floor, a space $2\frac{1}{2}$ feet square should be curbed off in one corner of each section of the house, to be used as a sand bath for the fowls. The sand within the curbing should be kept dry and clean, and in case sand is not available, finely powdered ashes are sometimes substituted. The principal objections to ashes, however, are that they are likely to contain sharp particles which have a tendency to cut the down on the feathers, and that their attraction for moisture makes it necessary to change ashes oftener than sand.

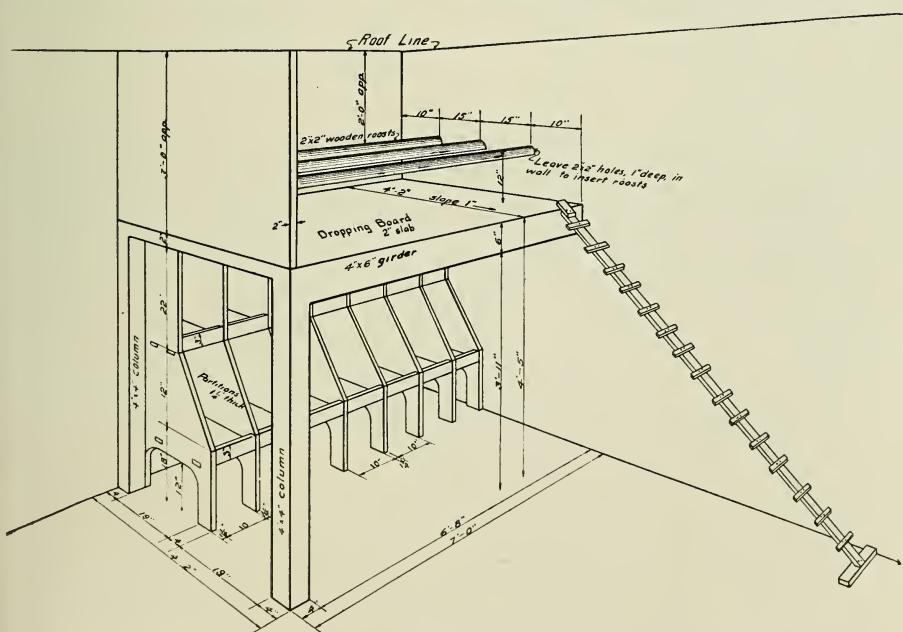


Figure 96. Perspective view showing concrete hens' nests and dropping board in position.

The curb around the sand bath should be put in at the same time as the floor, and for this work only simple form boards are required. Four inches will be found a convenient width for the curb, which should extend up above the floor about the same distance.

Roosts. A simple wooden ladder will serve as an approach to the roosts. The dropping board should consist of a concrete slab 2 inches thick and should be given a slope of 1 inch to the foot, to facilitate cleaning. The roosts are made of 2x2-inch wooden strips which fit into 2x2-inch pockets in the wall on one side and into a little shoulder with a recess for support on the other side. This scheme makes it possible to remove the roosts for cleaning and disinfecting.

Nests. Concrete is a very good material for use around poultry houses, because of the fact that it contains no crevices to harbor vermin. Experts declare they have found no case where a setting hen has left a concrete nest because of lice. This freedom from lice makes it possible for the bird to retain more flesh at the end of the setting period and

therefore, more strength. The little chicks are accordingly stronger because they are not hatched in the breeding place of hungry lice.

Figures 96 and 97 show the plan and detail for making concrete hens' nests. This scheme is applicable to any hen house as the individual parts are made separately and erected in place. The concrete nests are constructed as follows: the 4 x 4-inch column, 4' x 6-inch girder, and the dropping board should be cast in one operation. The 2-inch slab to the left (Figure 96) may be cast separately and put in place

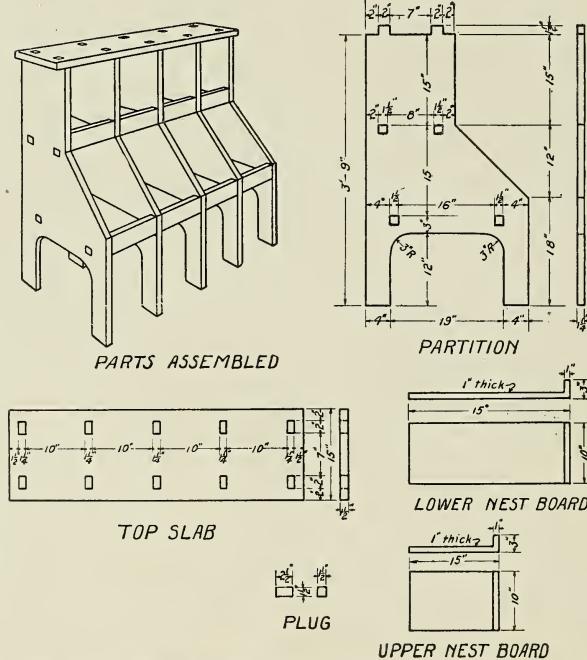


Figure 97. Plan for a Battery of Concrete Hens' Nests, suitable for use in Concrete Poultry House.

later. This slab extends to the roof and is intended to prevent drafts from reaching the chickens on the roosts.

The sides of the nests may be cast in unit sections in a mold similar to that shown in Figure 43. The top end of the nest partitions are provided with two projections, which fit into corresponding openings in the concrete slab directly above, (shown in Figure 97,) and are sealed with concrete mortar after being placed in position. The lower nests

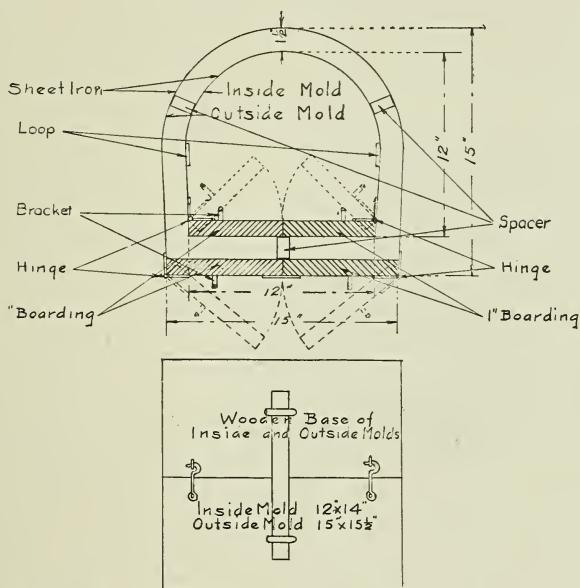


Figure 98. Mold for making individual hen's nests for outside use. Hens do not abandon lice-proof nests and chicks do not become the prey of a legion of hungry lice.



Figure 99. Concrete Hens' Nests and Molds of John Christensen, St. Charles, Illinois. Mold made by B. M. Bangs & Co., Lake Mills, Iowa. The two objects to the left are the outer and inner molds, while front and back views of the nests are shown to the right.

project beyond the upper nests as shown, making it possible for the hens to fly to the higher nests without difficulty.

The bottom boards for the nests are cast separately as shown in Figure 97, the slab being 1 inch thick with a projection across the front 3 inches thick. This projection serves as a perch for the birds to light upon and prevents the eggs from rolling out of the nest. The bottom of the nests slip in between the partitions, and are supported by little concrete lugs which slip into mortices cast in the partition. At the rear of the room, directly back of the nests, there should be an alleyway 4 feet wide. By means of holes in the partition wall, it is possible to remove the eggs from the nests from this alleyway.



Figure 100. Concrete Poultry House of C. W. Boynton, Chicago. Cement plaster construction on woven wire lath supported by a framework of concrete columns and beams.

Figure 99 shows a concrete nest for outside use. Such nests are valuable because they can be placed anywhere, are water-proof and vermin-proof, and are practically unbreakable. The forms for making these nests are manufactured by B. M. Bangs, Lake Mills, Iowa.

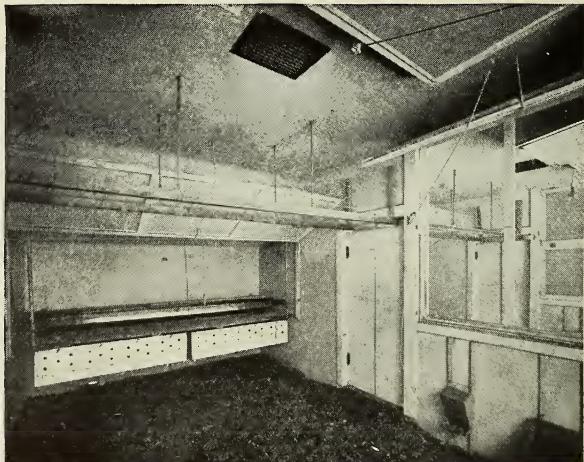


Figure 101. Interior of Concrete Poultry House, Iowana Farm, Davenport, Iowa. The model home of Col. French's fine flocks of White Orpingtons.

Concrete Hog Houses

THE United States raises nearly one-half of the world's supply of swine. The price of pork has advanced steadily during the past two or three decades, and the future trend of figures will undoubtedly be upward. The increasing value of pork products should find hog raisers alert to stop every loss. It is at once an argument for hog saving as well as hog raising. With the proper care and attention, and the hogs housed in healthful and sanitary quarters, there is no reason why much of the annual loss of swine flesh cannot be stopped, and the profits of hog breeders proportionately increased.

F. G. Moorhead, writing on the present campaign to stop the needless slaughter of young pigs in Iowa, says in a recent number of the Technical World Magazine : "It was the average of twenty-five pigs lost on each farm each year which wrinkled most of the experts' brows, for there are 209,000 farms in Iowa, which means that 5,000,000 little porkers give up the ghost uselessly each year." If reliable, these figures are astounding in themselves, but even greatly more so when it is considered that conditions similar to those in Iowa hold in almost every hog-producing state in the Union.

The introduction of concrete about the hog pen has been productive of excellent results, both by improving the conditions under which the swine are housed and fed, and by making possible a saving in labor,



Figure 102. Hog House of John E. Holden, Carson, South Dakota, built of Defiance concrete blocks. The owner found this material cheaper than wood and of course more sanitary and permanent.

maintenance expenses and feed. The general use of concrete for breeding houses, shelters, troughs, wallowing pools and feeding floors should bring about even further economies, as well as raise the standard of the stock and prevent much of the large loss of young pigs, due to exposure, unsanitary conditions and accidental death. Recent Government bulletins on the subject of hog tuberculosis point clearly to decaying wood construction as a chief source of infection.

Notwithstanding the advice of swine experts generally, a large proportion of our farmers provide nothing more than a sheltered pen in which to keep their hogs during cold weather. In such cases the sows are not bred to farrow until late; or if they do farrow early, the loss of pigs is large. February and March pigs are, as a rule, the most profitable, and to successfully raise these in the northern states requires a tight, substantial house, often equipped with provision for heat.

During the winter of 1903-04 a series of interesting experiments were conducted by the Central Experimental Farm, Ottawa, Canada, to determine the comparative economy of wintering hogs within the piggery and without. Results show that a number of brood sows kept in a warm house were maintained in good condition at 25 per cent less expense than an equal number of sows wintered in the shelters occupied during the summer. The cost of feeding nine fall pigs kept within was found to be \$3.85 per hundred pounds increase in live weight, while that of feeding eleven fall pigs maintained without was \$5.42 per hundred pounds increase. Besides this saving of 29 per cent in actual cost of feed, the pigs kept within gained in weight somewhat faster than those kept without.



Figure 103. Concrete Block Machine Shed and Hog House on the farm of Fred Rownd, Cedar Falls, Iowa. Permanent buildings of pleasing appearance and practical design.

Types of Concrete Hog Houses. In the following pages designs for three general types of hog houses are shown: First, those used merely as shelter houses; second, the small breeding houses, used principally for early litters; third, a large house designed to accommodate a score or more of brood sows. Explanations of the available methods of construction—monolithic, block, panel and cement plaster—are given in the preceding chapters, while the necessary instructions for applying stucco coats to wooden, brick or concrete block buildings will be found on pages 52 to 57.

Small Shelter House of Unit Construction

THE accompanying diagram, Figure 105, shows a plan and elevations of a small shelter house (17 feet 6 inches by 9 feet 1 inch). The walls and roof of the house are supported on 8 x 8-inch reinforced concrete posts, and placed 8 feet 5 inches apart, center to center. The posts used on the front of the structure are 9 feet long, and those used on the back 8 feet 5 inches long, the roof thus being given a 6-inch slope. The posts are each reinforced with four $\frac{1}{2}$ -inch round rods, which are laced together diagonally with wire, for the purpose of strengthening the walls of the grooves. Recesses are provided to receive the wall slabs, each recess being 2 inches deep, $2\frac{3}{4}$ inches wide at the surface, $2\frac{1}{2}$ inches wide at full depth, and extending from the upper end of the column to a point $3\frac{1}{2}$ feet from the lower end.

In making the post or beam, the mold should be placed as shown, and concrete made of one part cement to two parts coarse sand to four



Figure 104. Hollow Wall Monolithic Hog House of Charles Rauner, Laramie, Wyo. The building is 16 feet by 42 feet, with a height of 12 feet to the ridge of the roof. It is designed to contain 8 pens on each side of a center passageway.

parts screened gravel or crushed stone put in to a height of one inch. Two reinforcing rods are then placed upon the concrete, wires being passed around the rods at intervals of 18 inches, and the ends twisted together and brought up diagonally. The mold is then filled with concrete to within an inch and a half of the top, the remaining two reinforcing rods laid upon this, and the diagonal wires brought out and twisted around them. The mold is then completely filled. A 1:2:4 mixture will give ample strength, but if it does not give sufficiently smooth surfaces, the proportion of stone should be decreased until the

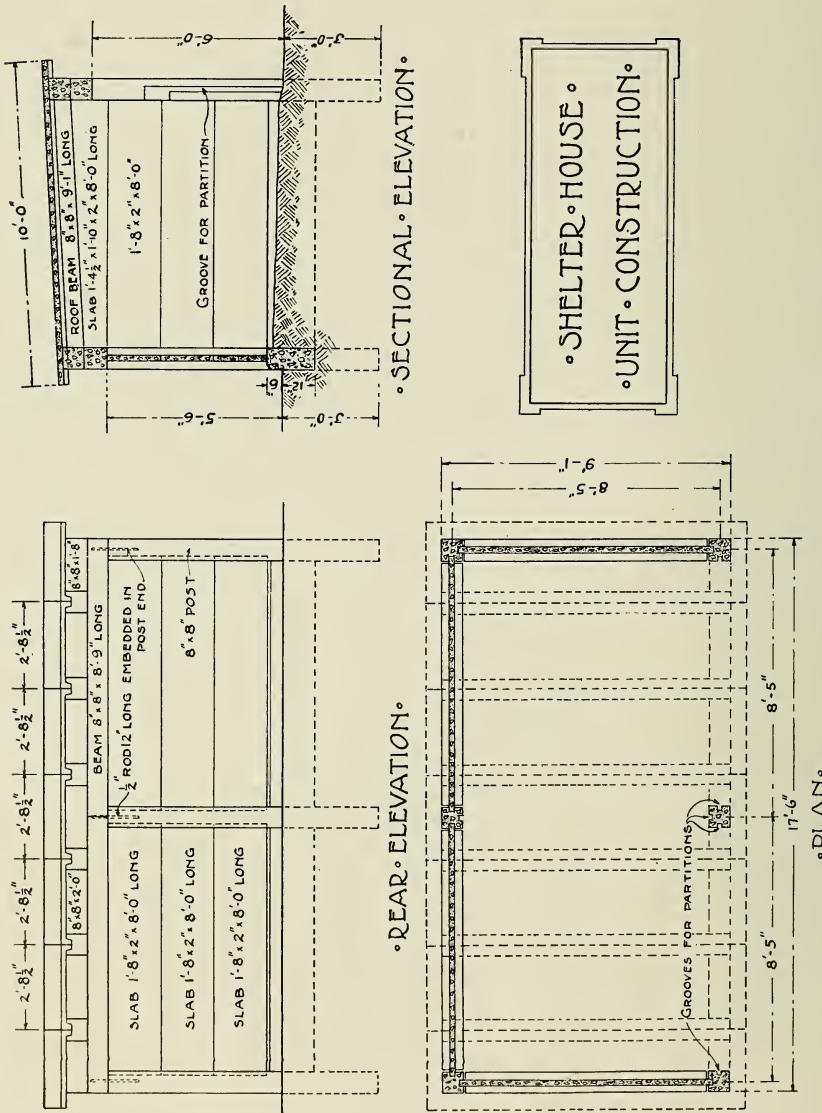


Figure 105. A Concrete Shelter House of unit construction, cheap and portable.

desired results are obtained. After removal of the mold, each post or beam should be allowed to cure two or three weeks before using, and during this time should be stored where plenty of moisture can be provided.

The posts may conveniently be hoisted into position with a tripod and tackle, as shown in Figure 44. When placing the posts, care must be taken in securing the proper spacing, alignment and height, as negligence in this regard will cause extra work.

As soon as each post is placed the earth must be well tamped around it to within one foot of the surface. A small quantity of water may be poured in around the posts, as this helps to compact the soil. Excavation should next be made between the posts on the three enclosed sides for a curb, which will be the same width as the posts, extending 6 inches above ground and 12 inches below ground. No curb will be required on the open side of the house unless a floor is to be put in. The forms for the curbing should be put up and filled with concrete of the same mixture as recommended for the posts. The top of the curb must be flush with the ends of the recesses in the posts. Each section of curb 7 feet 9 inches long requires about 2 sacks of cement, $5\frac{1}{2}$ cubic feet of sand and 9 cubic feet of gravel or stone. If a concrete floor is desired, the surface should be 2 inches below the curb line, and the space between the surface of the floor and the top of the curb filled with bedding. If a dirt floor is to be put in, the surface may be made flush with the curb.



Figure 106. Concrete Block Hog House on the farm of Eugene D. Funk, near Shirley, Illinois. This house, which is 42 feet by 24 feet in dimensions, contains 10 pens, a feed room and a store room. The walls were built of 8-inch by 16-inch solid concrete block, $5\frac{1}{2}$ inches thick, and were later finished off with cement stucco. The floors are of concrete. In connection with this house Mr. Funk also has a large concrete feeding floor.

The wall slabs are all 8 feet long and 2 inches in thickness and may be varied in width to fit the space to be filled. They may be conveniently made in the mold shown in Figure 107, using the top form only. These slabs, as well as those for the roof, should be made of a 1:2½:2 mixture. The gravel or stone must be between $\frac{1}{4}$ -inch and $\frac{1}{2}$ -inch in size. The width of each slab is 20 inches, with the exception of the upper slabs for the ends of the building, which are 14 inches wide at the back and 20 inches wide at the front. The reinforcing consists of $\frac{1}{4}$ -inch round rods, spaced as indicated on the diagram. The slabs are raised and slipped into the column recesses, with the assistance of the tripod and tackle, and are sealed in place with mortar, this work being done as outlined on pages 48 and 51.

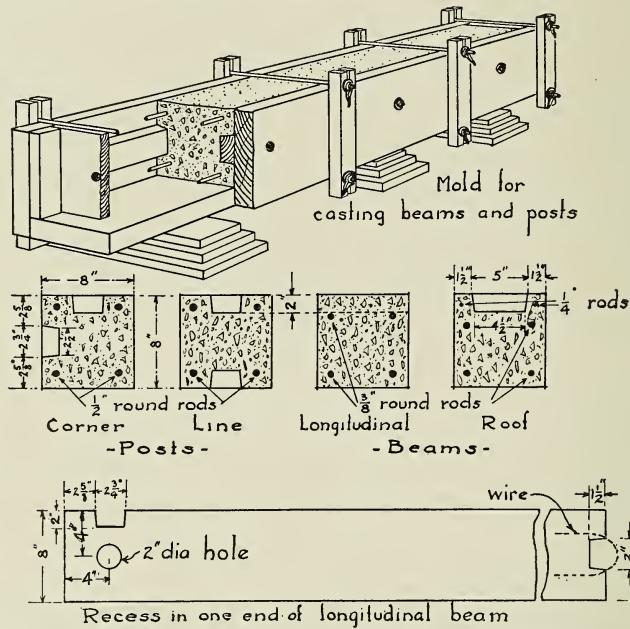


Figure 107. Post and Beam Mold, cross sectional views of posts and beams for slab shelter house, and plan of a longitudinal beam.

By removing the cleats used to provide recesses, the mold required for casting the posts also serves to cast the longitudinal beams. Four of these are required, and the length of each is 8 feet 8 inches. Four $\frac{3}{8}$ -inch round reinforcing rods are used. Referring to Figure 107, bottom illustration, it will be noticed that the ends of both longitudinal beams are to be recessed on one side at a point $2\frac{5}{8}$ inches from one end, this being necessary to provide slots for the upper end slabs. When the house is made more than two sections in length, intermediate longitudinal beams need not be recessed in this way.

The longitudinal beams are held in position by steel pins placed in the top end of the columns and allowed to extend up through holes in the beams. These holes are made by placing wooden plugs in the mold and drilling out the plugs when the beams are ready to be put up.

Where two longitudinal beams adjoin each other, as is the case at the center posts on the front and back, a half-round section is left in the abutting ends of each, so that the steel pin may come up between them. Wire loops placed in these ends, as shown, will aid in holding the beams in place. All beams must be laid in a bed of grout or mortar.

The post mold is also utilized for the purpose of casting the roof beams, which are 10 feet long and 8 inches by 8 inches in section, with a depression in the top side, into which the roof slabs fit. This depression is made by placing in the mold a strip of wood of the required size. The roof beams are reinforced with four $\frac{3}{8}$ -inch round rods and two $\frac{1}{4}$ -inch round rods placed as shown in Figure 107.

The $\frac{1}{4}$ -inch rods should be laced to adjacent $\frac{3}{8}$ -inch rods with baling wire or similar material, at intervals of 12 inches. Concrete of a 1:2:4 mixture is used. The distance between beams is 2 feet $8\frac{1}{2}$ inches, center to center, and the spacing must be accurate. Between beams at the wall line there is a space of $24\frac{1}{2}$ inches long by 8 inches high, which may be filled either by concrete blocks or by concrete deposited in place, as desired.

The roof slabs (See Figure 109) are made in a mold arranged to provide lugs or flanges on both sides. For the end slabs, piece (b) is moved in $2\frac{1}{2}$ inches, which gives it a bearing on core (a) and produces a lug on only one side, making a slab 2 feet $5\frac{1}{2}$ inches in width. A pallet is necessary for casting these slabs, this being required to hold core (a) in position. The sides and ends of the molds are held tightly to the pallet by steel clamps, which may be made of heavy wagon tires or



Figure 108. Concrete Block Hog House on Henry Hanson's Echo Valley Farm, Odebolt, Iowa. Comfortable and airy quarters for the porker inevitably lead to increased profits. Mr. Hanson's hog house is pleasing in appearance and moderate in cost.

similar material, so bent as to be $5\frac{1}{2}$ inches in width, with one leg 4 inches long and the other 6 inches long. For casting and roof slabs, the clamps bearing upon the block (b) should be placed with the 6-inch leg up and the 4-inch leg under the pallet, while for other slabs these clamps will be used in the reverse position.

After the roof slabs have been placed upon the beams, the spaces between slabs may be filled with pitch or grout although this is optional and not necessary to make the roof watertight.

Roof slab mold as shown

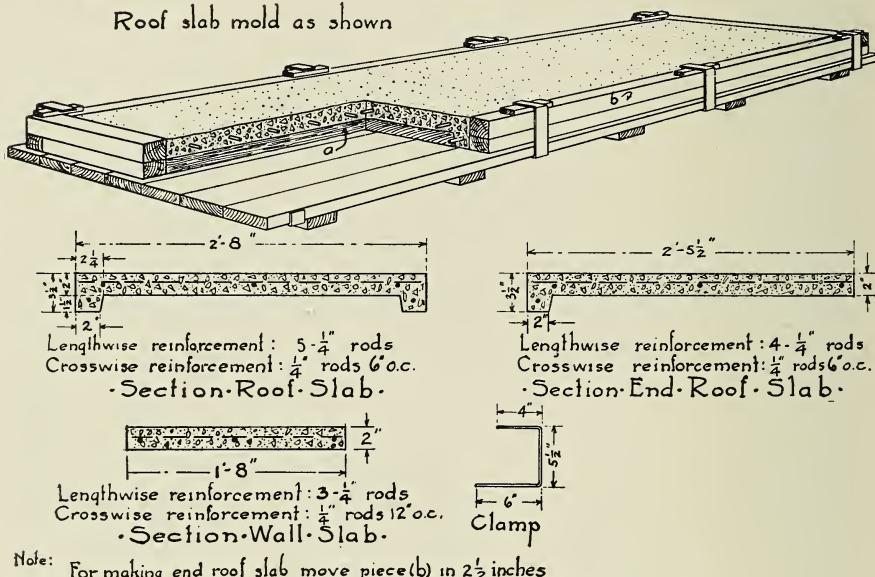


Figure 109. Slab Mold.

Table of Concreting Materials

Members	Mixtures	Cu. ft. Concrete	Sacks Cement	Cu. Ft. Sand	Cu. Ft. Gravel or Stone
Posts.....	1:2 :4	24.6	5 $\frac{1}{2}$	11.0	22.0
Beams.....	1:2 :4	42.8	9 $\frac{1}{2}$	19.3	38.0
Side Slabs.....	1:2 $\frac{1}{2}$:2	24.0	6 $\frac{1}{2}$	16.6	13.3
Roof Slabs.....	1:2 $\frac{1}{2}$:2	32.0	9	22.5	17.8
Total.....		124 Cu. Ft.	30 $\frac{1}{2}$ Sacks	69.4 Cu. Ft.	91.1 Cu. Ft.
Cement at \$2.00 per bbl.....					\$15.25
Sand at \$1.00 per cu. yd.....					2.57
Gravel at \$1.00 per cu. yd.....					3.38
Total cost of concreting materials.....					\$21.20

REINFORCING METAL—BILL OF MATERIALS

12 pcs. $\frac{1}{2}$ -inch round rod 18 feet long, 144 lbs. at \$1.90 per 100 lbs.	\$ 2.74
20 pcs. $\frac{3}{8}$ -inch round rod 18 feet long, 135 lbs. at \$2.05 per 100 lbs.	2.77
72 pcs. $\frac{1}{4}$ -inch round rod 18 feet long, 216 lbs. at \$2.30 per 100 lbs.	4.97
Total cost of reinforcing metal.	\$10.48

THE above bill of materials is based upon the economical use of the rods. The prices given are quite generally quoted by steel manufacturers in the central states.

The forms for the various members are simple to construct, and if attention is paid to the designs shown in Figures 107 and 109, no further instructions should be necessary. 2-inch dressed lumber is best for use in all parts of the forms except the pallets or bottom boards, which may be made of lighter material if properly supported.

If it is desired to build this house with monolithic concrete, blocks or cement plaster, instead of separately molded members, the slab roof may be used in any case with satisfactory results. For a monolithic block or cement plaster house the foundation walls should be 6 inches in width and deep enough to extend below the frost line, the work being done in accordance with instructions given in the chapter on "Foundations." If the walls are to be of monolithic construction they may be continued up on three sides to a point 5 feet above the foundation, leaving the fourth side open. A reinforced column, 5 feet in length, previously cast in the mold box shown in Figure 107, is then placed in position on the open side of the building, midway along the foundations. Longitudinal beams of the same type and dimensions as those used in the unit construction are then placed in position. The roof beams are next put on as heretofore described and the side walls built up flush with the tops of the roof columns. As soon as the walls are sufficiently hardened the structure is ready for the roof slabs.



Figure 110. An Iowa Hog House equipped with steam heat, King System of ventilating and litter carrier system.

To construct the house of concrete blocks, the foundation is laid as before, care being taken to level off the top. The walls should be laid as directed in the chapter on "Concrete Block Walls." The beams used over the openings may be the same as those used for the hog house of unit construction, the same being true of the roof beams. After the latter are in place, the side walls are continued up level with the lower end of the roof beams, and the spaces between these beams are filled in with blocks or monolithic concrete. The end walls are also continued up of monolithic concrete until flush with the tops of the roof beams, which are placed in the usual manner. This house will require about 220 standard 8x8x16-inch blocks and 22 8x8x8-inch half blocks, if built to a height of 5 feet 4 inches between the lower end of the roof and the ground. If it is desired to construct the house with cement plaster walls, posts, curbs, beams and roof should be erected as for the unit house. Metal lath is then stretched around the structure and wired to the posts and beams at close enough intervals to make it rigid. Plaster coats should be applied to the metal lath as described on page 52.



Figure 111. Interior of Concrete Milk House and Creamery, Iowana Farm, Davenport, Iowa. In a concrete structure absolute cleanliness can be maintained at all times, with a minimum amount of work.

A Five-Pen Hog House of Concrete Blocks

THIS house is designed to shelter a small number of sows with winter litters. It has concrete block walls, and a reinforced concrete roof, supported by concrete columns and ridge beams. The concrete floor has provision for drainage, and the ventilation system supplies plenty of fresh air without compelling the hogs to lie in a draft. Before farrowing time the floor of the pen where the sow makes her nest should be covered with a mat made of 2 x 4's with a liberal supply of bedding placed upon them. These mats may be removed when the pigs are a few weeks old.

Directions for putting in the foundations for the building will be found on pages 15 to 21. The wall blocks, as well as the concrete window sills and lintels, may be purchased from the nearest dealer, or made on the place with equipment described on pages 45 and 47. The window and door framing is simple and can be executed by anyone with a little experience in carpentry.

The piers or footings for the support of the center columns are put in at the same time as the wall foundation, box forms, like that shown in Figure 112, being used. The four $\frac{3}{8}$ -inch reinforcing rods for the columns must be securely embedded in the piers, care being taken to space the rods properly. After the piers have become hard enough to support the weight of the columns, forms for the latter (See Figure 122) are erected and filled with concrete wet enough to be quaky. The tops of the columns should be left squared off with reinforcing rods protruding about 8 inches. These will later be embedded in the ridge beam above.

The ridge beam and roof should be cast together as a monolith, using forms similar to that shown in Figure 131. Simple box forms, supported by light scaffolding, will suffice for the eaves. The reinforcing rods in the ridge beam should be placed $1\frac{1}{4}$ inches above the bottom of the beam and wired to the column reinforcing. The stirrups, which consist of $\frac{3}{8}$ -inch rods bent into U-shape, are 12 inches high. They are placed in pairs, 6 inches to either side of each column and 12 inches apart, as shown in the section and elevation of the beam, in Figure 114. Two additional $\frac{1}{2}$ -inch reinforcing rods 4 feet long, are put in above each column, about $1\frac{1}{4}$ inches below the top of the beam.

The concrete for the roof should be mixed wet enough to be mushy, and the entire roof should be placed at one operation if practicable. Should it be impossible to do the work continuously, the sections must be joined together as directed on page 58, (chapter on roofs) making

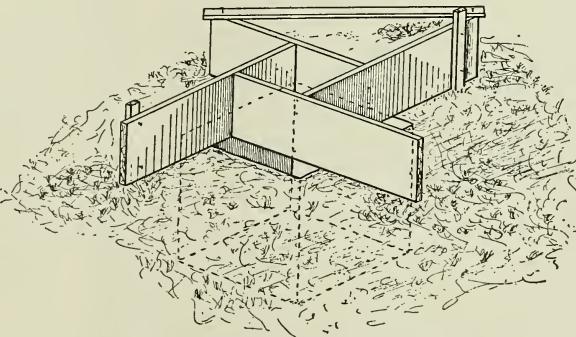


Figure 112. Simple Box Mold for Column Footing.

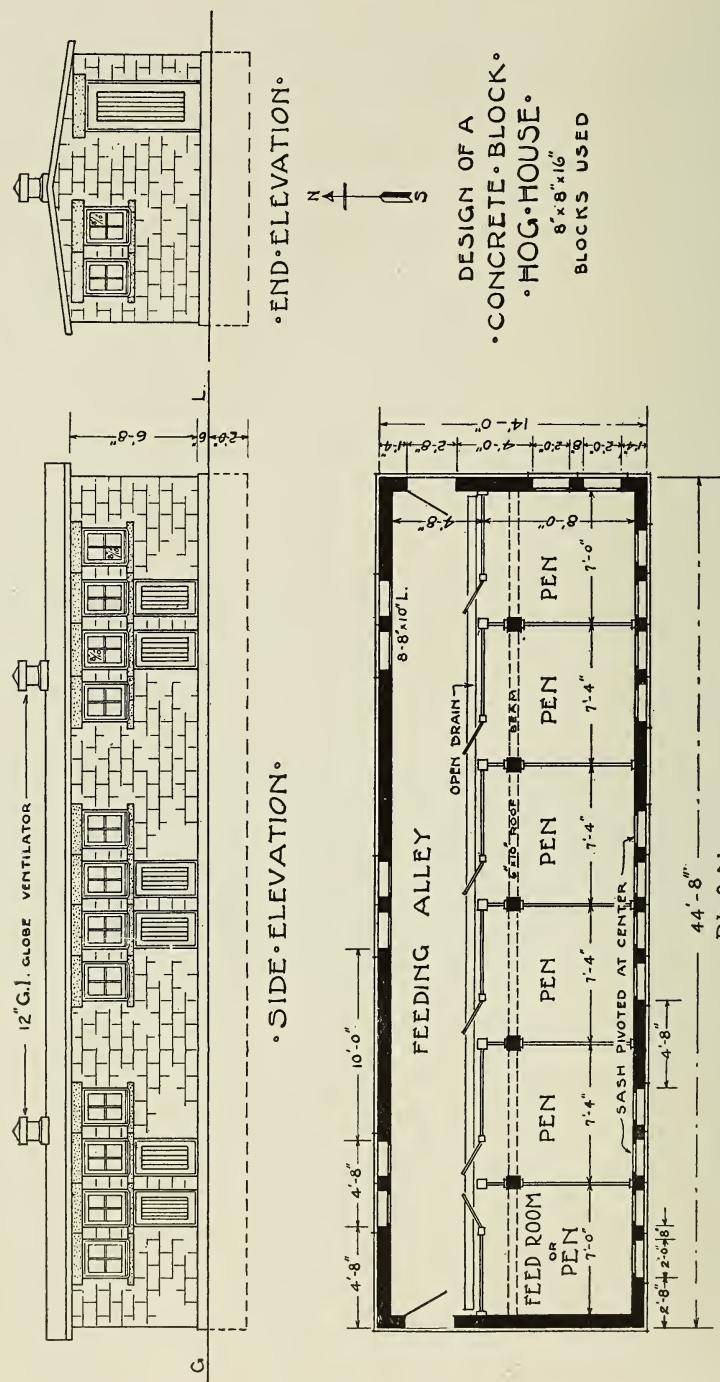


Figure 113. A Fine Pen Hog House of Concrete Block. Many hog raisers use houses of this type for early farrowing, housing later litters in less substantial structures.

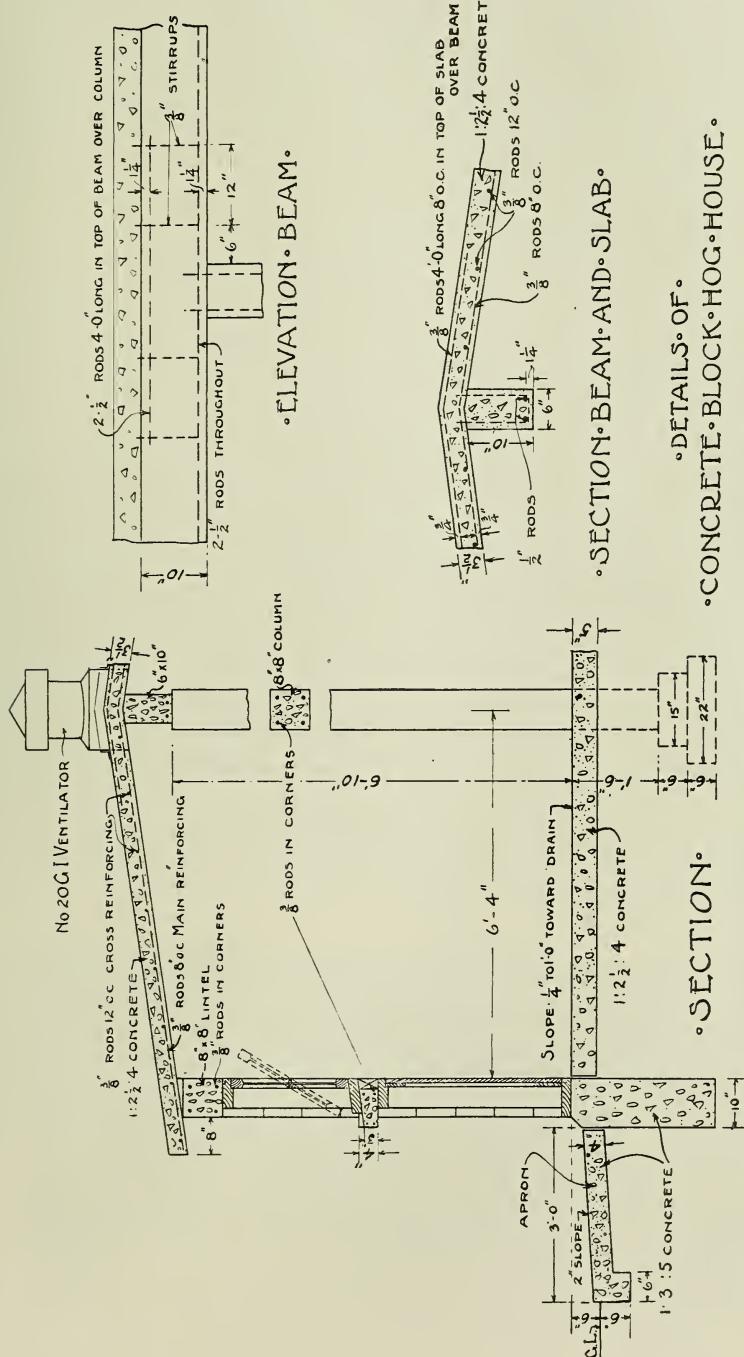


Figure 114. Detailed Sectional Views, Five Pen Hog House of Concrete Blocks.

all joints run from ridge to eave, and never in any other direction. A mixture of 1:2:4 should be used for the ridge beam and body of the roof. The roof should be finished off in the same manner as a sidewalk and protected against sun, wind and frost for two weeks by covering with wet straw, weighted down to keep it in place. The forms must be left in place until the roof is thoroughly hardened and all doubts as to the strength of the work removed.

Proportions (See page 157).

Foundations and Apron, Specification D.

Floor, and Body of Sills and Lintels, Specification C.

Body of Concrete Blocks, Columns, Beams and Roof Slab, Specification B.

Mortar Facing for Blocks, Sills and Lintels, and for Laying Blocks, 1:2 cement and sand.

Table of Materials

	VOL. Cu. Yds	MIX- TURE	CEMENT		SAND		STONE	
			Bbls.	Sacks	Cu.Yds.	Cu.Ft.	Cu.Yds.	Cu.Ft.
Foundations.....	9.45	1:2½:5	11.72	47.00	4.35	117.2	8.70	235.0
Apron.....	5.40	1:2½:5	6.70	27.00	2.50	67.5	5.00	135.0
Concrete Blocks { Body.....	....	1:2:4	12.85	52.00	3.85	104.00	7.59	205.0
Concrete Blocks { Surface.....	....	1:2	3.10	12.50	.70	19.0	....	....
Sills and Lintels.....	....	1:2½:4	2.15	8.50	.80	21.5	1.26	34.0
Columns.....	.70	1:2:4	1.06	4.00	.32	8.5	.62	16.5
Roof Beams.....	.70	1:2:4	1.06	4.00	.32	8.5	.62	16.5
Roof.....	6.80	1:2:4	10.28	41.00	3.06	82.5	6.06	163.5
Floor.....	8.50	1:2½:4	11.80	47.00	4.33	118.0	6.96	188.0
Total.....			60.72	Bbls. 11.23 Cu.Yds. 36.81 Cu.Yds.				

Allowing for a sufficient quantity of 1:2 cement and sand mortar, the total concreting materials necessary will be about 64 barrels of cement, 12.5 cubic yards of sand and 37 cubic yards of screened gravel or crushed stone.



Figure 115. Concrete Hog House on Barber Estate, Barberton, Ohio.

Approximate amount of Reinforcing required:

Crosswise Reinforcing in Roof,	68 $\frac{3}{8}$ -inch rods 16 feet long.....	Weight 408 Lbs.
Lengthwise Reinforcing in Roof,	48 $\frac{3}{8}$ -inch rods 16 feet long.....	Weight 288 Lbs.
Column Reinforcing,	20 $\frac{3}{8}$ -inch rods 12 feet long.....	Weight 90 Lbs.
Ridge Beam Reinforcing,	6 $\frac{1}{2}$ -inch rods 16 feet long.....	Weight 64 Lbs.
Stirrups,	6 $\frac{1}{2}$ -inch rods 12 feet long.....	Weight <u>48</u> Lbs.
	Total.....	898 Lbs.

(Order about 10 per cent extra to allow for waste.)

Concrete Blocks, Sills and Lintels

20 corner blocks.....	8"x8"x16"
485 wall blocks.....	8"x8"x16"
19 $\frac{3}{4}$ wall blocks	8"x8"x12"
113 $\frac{1}{2}$ wall blocks.....	8"x8"x 8"
16 $\frac{1}{4}$ wall blocks.....	8"x8"x 4"
13 special blocks, 4" high, 8" long, 8" thick, to fit around window sills.	
20 sills.....	32" long, 4" high, 10" thick
20 lintels.....	32" long, 8" high, 8" thick
2 lintels	40" long, 8" high, 8" thick

IF it is desired to build the house with monolithic concrete walls, the work may be carried on in the same manner as for the larger structure described on pages 137 to 140 of this booklet. The walls should be 8 inches in thickness, made of a mixture of 1 sack of Portland cement to $2\frac{1}{2}$ cubic feet coarse sand, to 5 cubic feet screened gravel or crushed stone. If these proportions do not give as smooth surfaces as desired, the amount of stone should be decreased until a 1:2 $\frac{1}{2}$:4 mixture is obtained. Sufficient reinforcing must be placed around the window and door openings.

The following materials will be needed to build monolithic walls for this structure: 16.5 barrels of cement, 6 cubic yards of sand and 12 cubic yards of stone. A good description of the forms required for this work will be found in the chapter on "Monolithic Walls," pages 32 to 44.



Figure 116. Concrete Block Calf and Hog House on farm of C. S. McNett, Cary, Illinois. Built by the owner.

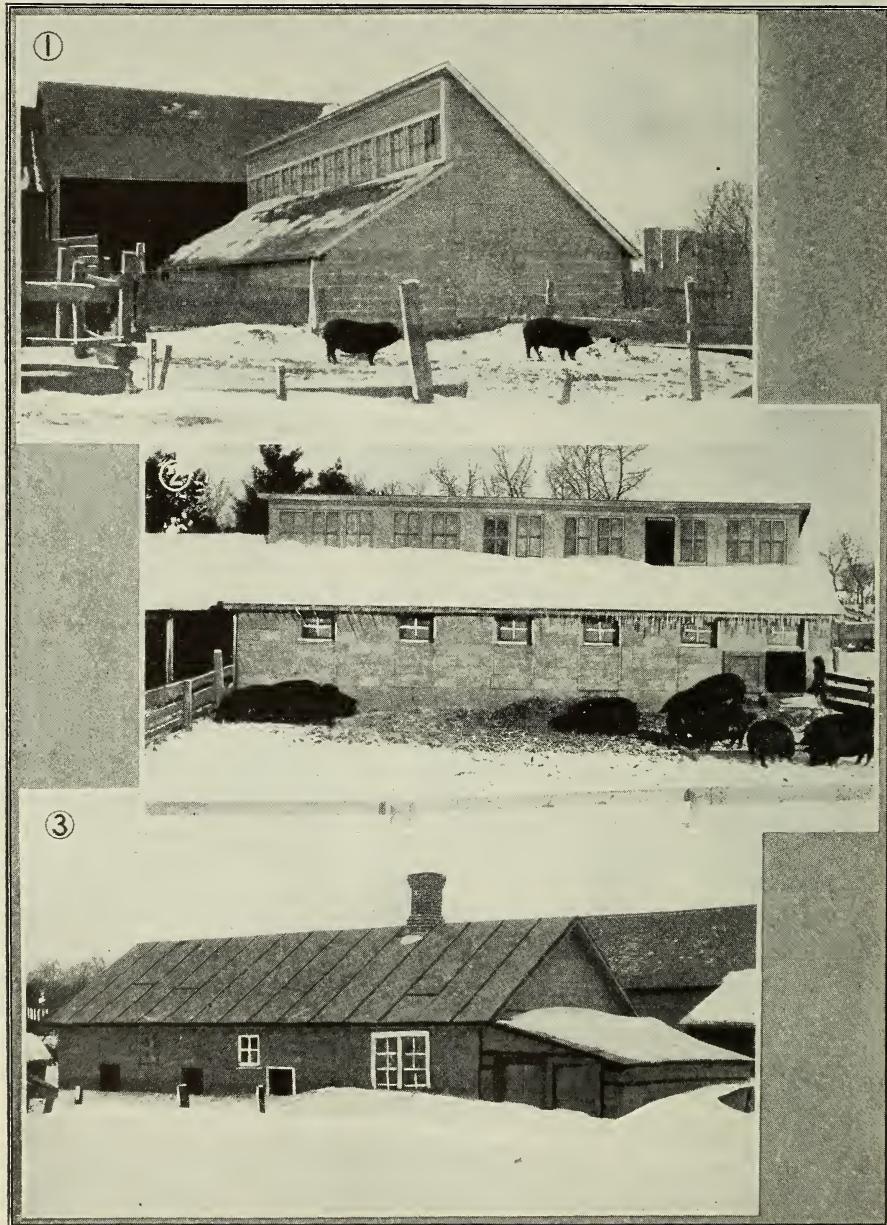


Figure 117. WINTER HOG HOUSE SCENES

- (1) Jacob Brinkman's Hog House, Early, Iowa. Dimensions, 22 feet by 40 feet. Cost, \$300.
- (2) P. Schaller's Hog House, Early, Iowa. Dimensions, 18 feet by 36 feet. Cost, \$300.
- (3) K. J. Ammentorp's Hog House, Withree, Wisconsin. Dimensions, 35 feet by 9 feet. Cost, \$160.

A Five-Pen Cement Plaster Hog House

THE unit-frame, plaster-wall hog house shown in Figure 118 is designed to meet practically the same requirements as the one described on the pages immediately preceding, varying widely from the latter, however, in the method of construction. The walls are cement stucco applied to metal lath, which is supported upon a frame of reinforced concrete columns and beams, and stiffened by vertical and horizontal reinforcing rods.

In constructing the house, the procedure should be about as follows: The necessary columns and beams are first cast in mold boxes similar to those shown in Figure 107, of a mixture of 1 sack Portland cement to 2 cubic feet of clean, coarse sand, to 4 cubic feet screened gravel or crushed stone. The required number of columns and beams, their sizes and amount of reinforcing metal in each, is given in the following table. Reinforcing rods should be placed $1\frac{1}{2}$ inches from each corner, but need not be wired together in the manner heretofore described. Two of the reinforcing rods on corners diagonally opposite should be allowed to project 3 inches from the bottom of the column; this may be accomplished by boring holes in the ends of the molds and allowing the rods to project through. When the columns are set up these rods will be grouted into holes drilled into the foundation wall. Small pieces of fence wire should be placed in the sides of the columns which are to face out, these being used later to secure reinforcing rods and metal lath. These wires should be placed in the columns 12 inches apart.

The columns and beams should be given an opportunity to thoroughly harden and acquire strength before being placed in position, and during this period the foundation and center column footings should be put in. This foundation should be 12 inches wide and 2 feet 6 inches deep, while the footings or piers should be 1 foot 6 inches square for the first 6 inches, and 12 inches square for the 2 feet above, as shown in the sectional view of the house.

When the tops of the foundations and piers are being leveled off, two 2-inch holes, $3\frac{1}{2}$ inches deep, should be left at intervals of 7 feet along the foundation, and also on the top of each pier. These holes may be made by inserting in the work galvanized iron tubes, which are easily withdrawn later. They must be correctly spaced, of course, to receive the protruding reinforcing rods from the columns. Just before the columns are placed in position, the holes are filled with grout of a creamy consistency. The columns are then placed, and the reinforcing rods forced down through the grout, which soon hardens, giving a good bond.

The roof beams are next erected in the same manner as for the unit shelter house (see page 119). The monolithic slab roof is $3\frac{1}{2}$ inches thick. The roof forms may be erected the same as those for the concrete block house. The reinforcing consists of $\frac{3}{8}$ -inch rods spaced 12 inches apart, lengthwise, and 7 inches apart crosswise, placed $\frac{3}{4}$ -inch above the bottom of the roof. Additional reinforcing, consisting of $\frac{3}{8}$ -inch rods, 3 feet long, spaced 7 inches apart, should be put in astride

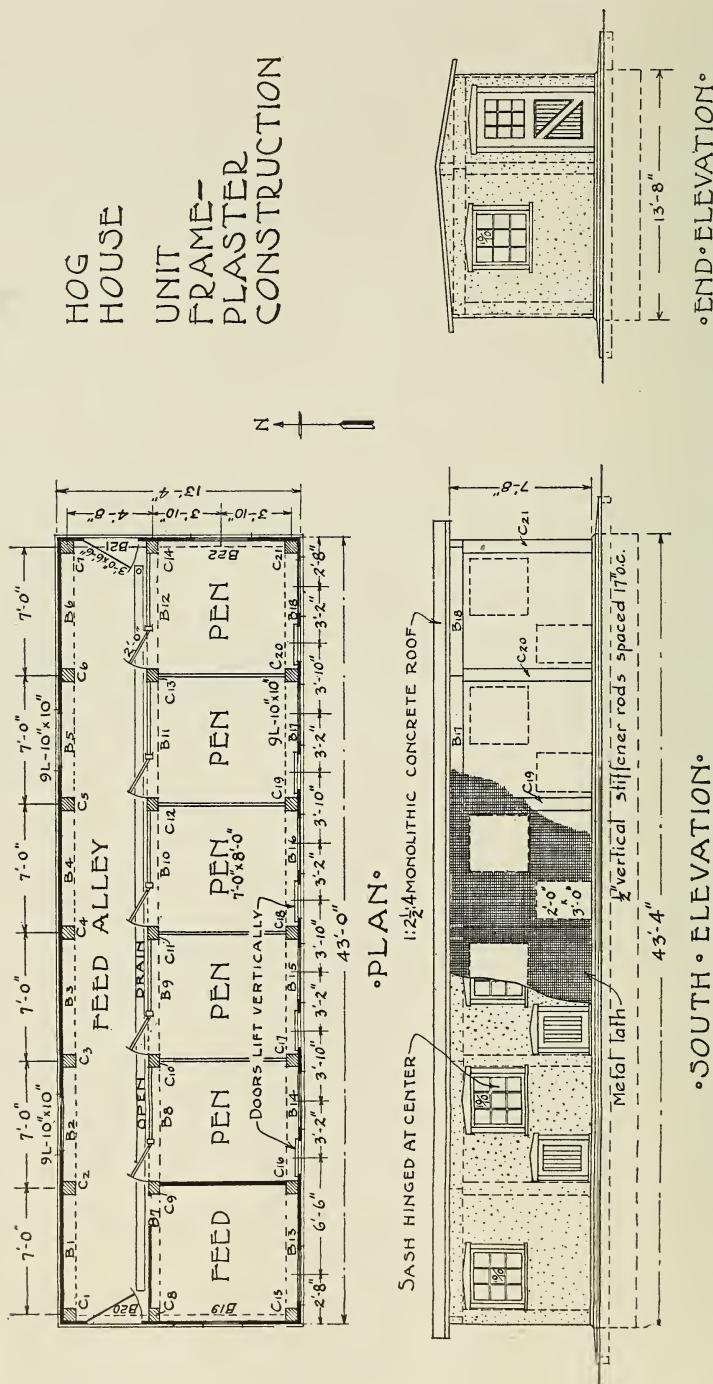


Figure 118. Plan and Elevation of a Cement Plaster Hog House with Reinforced Concrete Frame.

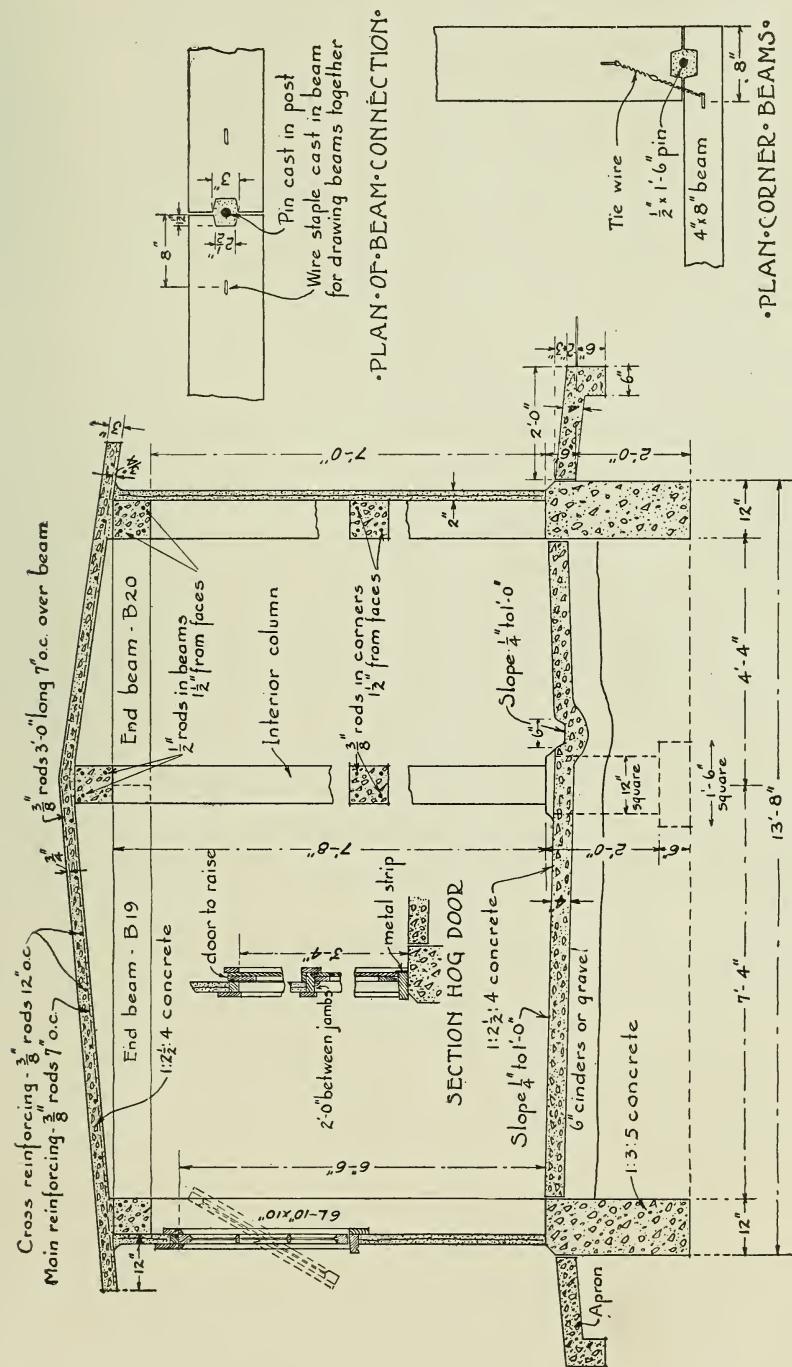


Figure 119. Detailed Sectional Views of Cement Plaster Hog House. The arrangement of columns and beams is clearly shown in this illustration.

of the ridge, as shown, one inch below the surface. The work must be surfaced with a steel trowel, and if difficulty is found in obtaining a smooth finish, a small amount of 1:2 mortar may be added. The roof must be protected from sun, wind and freezing, as heretofore described.

To the outside of the reinforced concrete frame $\frac{1}{2}$ -inch vertical reinforcing rods are wired at intervals of not more than 18 inches, so spaced that vertical reinforcing will fall 2 inches to each side of all window and door openings. If desired, the lower ends of these rods may be grouted into holes drilled in the top of the foundation. Only one horizontal reinforcing rod is required, this being a $\frac{1}{2}$ -inch rod, placed 3 feet 3 inches above the top of the foundation. The horizontal rod is wired to the vertical rods at each intersection.

Wire lath (described on page 53) may be obtained in convenient widths, and will be found a suitable material to receive the cement plaster. It should be wired to the reinforcing rods at intervals sufficient to hold it perfectly rigid, special care being taken to wire all laps so that both sections of the lath will act as a unit. Lath should be wired at intervals of not over 12 inches. The cement plaster coats should be applied according to the directions given on pages 52 to 57. If the frame is not sufficiently rigid to hold the first coat readily, temporary wood bracing should be put up. This may be removed as soon as the first coat is hard. Three coats should be applied to the outside of the wall, and one coat to the inside. The metal lath should be entirely encased in cement plaster, as exposed portions are subject to rust, which in the course of a short time causes the wall to be weakened materially.

Proportions (See page 157).

Foundations and Apron, Specification D.

Floor, Specification C.

Columns, Beams and Roof Slab, Specification B.

Plaster Walls, 1:2 $\frac{1}{2}$ cement and sand mortar.

Table of Materials

	VOL. Cu. Yds	MIX- TURE	CEMENT Bbls. Sacks		SAND Cu.Yds. Cu.Ft.		STONE Cu.Yds. Cu.Ft.	
Foundations and Footings...	10.80	1:2 $\frac{1}{2}$:5	13.40	53.60	4.96	134.0	9.94	268.0
Apron.....	3.70	1:2 $\frac{1}{2}$:5	4.58	18.32	1.70	46.0	3.40	91.8
Columns and Beams.....	4.77	1:2:4	7.20	28.80	2.15	58.0	4.25	115.0
Plaster Walls*.....	....	1:1 $\frac{1}{2}$	17.00	68.00	3.75	101.3	....	.....
Roof.....	6.25	1:2:4	9.44	37.76	2.81	76.0	5.56	150.0
Floor.....	6.50	1:2 $\frac{1}{2}$:4	9.04	36.16	3.32	89.7	5.34	144.0

Total..... 60.66 Bbls. 18.69 Cu.Yds. 28.49 Cu.Yds.

*Based on 1:1 $\frac{1}{2}$ cement plaster walls 2 inches thick, making no allowance for waste. At least 15 per cent additional material is generally required for the walls to take care of waste. See Table E, page 54.

A Large Reinforced Concrete Piggery

MUCH has been said of late both in favor of and in opposition to the centralized hog house. The large piggery has unquestioned advantages in the way of facilitating feeding and cleaning, as well as providing opportunity for use of artificial heat for winter farrowing and affording a good place to fatten pigs for market. On the other hand, the objection has been raised that with the centralized hog house, as ordinarily constructed of wood, there is greater danger from disease. However, with a concrete building all danger will be removed if ordinary care is taken and the house properly disinfected from time to time.

Figure 120 shows the ground plan and elevation, and Figure 121 the details of a large monolithic piggery having 24 ordinary pens, 1 special pen and a feed room. The walls are of monolithic concrete reinforced as directed on pages 39 to 44. (See elevation views, Figure 120.) The roof is of reinforced beam and panel construction, with windows set at proper angle to throw the sunlight down into the pens on the north side of the house during February, when it is most desired for early litters. The roof panels are supported by 8 x 15-inch beams placed on 7-foot 4-inch centers, these beams resting upon 8 x 8-inch columns. The floor is laid upon a sub-base of well tamped gravel or cinders, and is given a slope of $\frac{1}{4}$ -inch to the foot toward the drains, which are conveniently located to either side of the passageway.

The excavating for foundations and column footings, buildings of the forms and placing of the concrete may be carried on according to directions furnished in the chapter on "Foundations." The foundations have a width of 10 inches and a depth of 3 feet below the bottom of the hog doors. As soon as they have become sufficiently strong, the wall forms should be erected according to the directions given on pages 33 to 35.

Fifteen inches below the top of the inside of the wall, recesses 4 inches in depth, 8 inches wide and 15 inches high must be left for the roof beams. These recesses must be accurately spaced, so that they will be exactly opposite the corresponding columns. The recesses may be easily made by means of small core boxes.

For a house of this size it is advisable to build forms enough for but three or four columns and a like number of roof beams, unless the owner or the contractor will be able to make use of the additional lumber later. As soon as the walls are up, the columns, beams, and roof should be put up according to the following procedure: Forms similar to those shown in Figure 122, diagram A, should be erected for four columns and four roof beams. The columns should then be poured up to the under side of the lower roof beams. The reinforcing should be put in as directed in the description on page 39 and illustrated in Figure 35. As soon as the forms may safely be removed the next four columns are cast in a similar manner, this work continuing until these members are all in place.

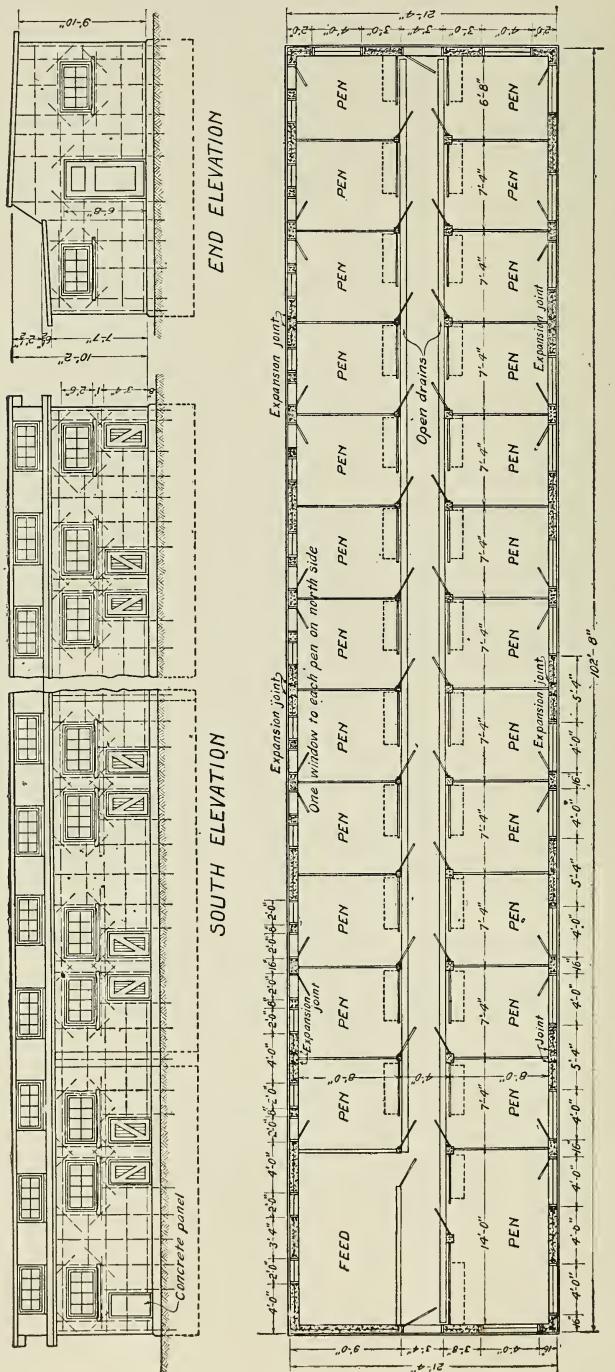


Figure 120. Plan of a Reinforced Concrete Hog-House, having 25 Pens and a Feed Room. When desired, concrete blocks may be substituted for monolithic walls, all of the dimensions being convenient for block construction.

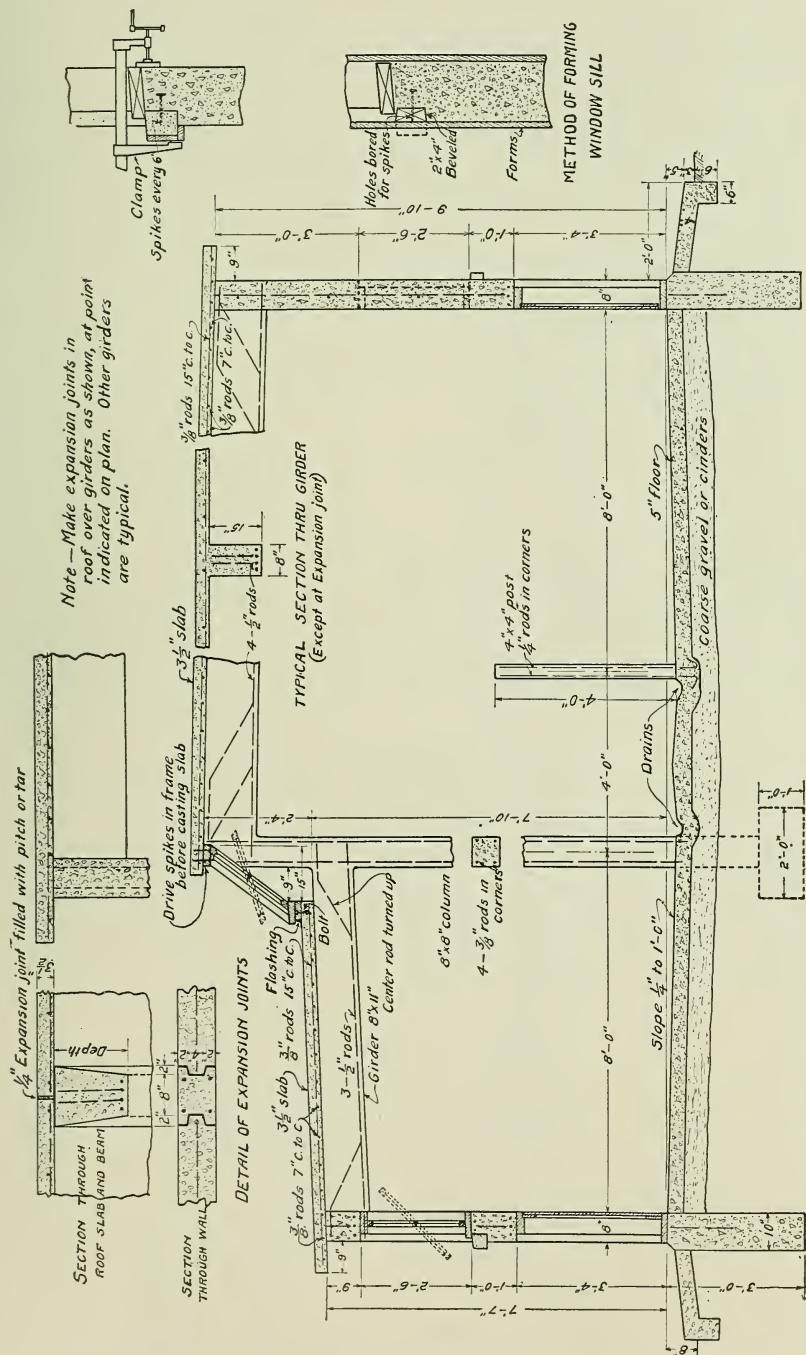
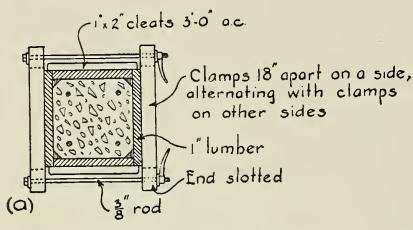
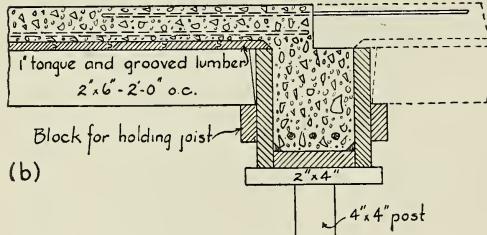


Figure 12. Sectional Details of Reinforced Concrete Hog House. The roof windows are set at an angle for the purpose of throwing the sun's rays upon the floor of the north pens during February and March.



SECTION COLUMN MOLD



BEAM AND SLAB FORMS

Figure 122. Sectional Views of Molds for Monolithic Columns, Roof Beams and the Roof Proper; the lower diagram shows the method of temporarily discontinuing roof work over beams.

D. Walls and Floors, Specification C.
and Roof Slabs, Specification B. Sills and Lintels, Specification A.

Table of Materials

	VOL. Cu. Yds.	MIX- TURE	CEMENT Bbls.	SAND Cu.Yds. Cu.Ft.	STONE Cu.Yds. Cu.Ft.
Foundations.....	15.12	1:2 $\frac{1}{2}$:5	18.75	75.00	6.96 187.8
Column Footings.....	2.36	1:2 $\frac{1}{2}$:5	2.93	11.72	1.08 29.2
Apron.....	7.03	1:2 $\frac{1}{2}$:5	8.73	34.92	3.23 87.3
Walls.....	40.58	1:2 $\frac{1}{2}$:4	61.35	245.40	18.22 492.5
Floor.....	31.25	1:2 $\frac{1}{2}$:4	43.50	174.00	15.93 430.1
Columns.....	1.92	1:2:4	2.90	11.60	0.86 23.2
Posts.....	0.20	1:2:4	0.31	1.24	0.09 2.4
Roof Beams.....	7.22	1:2:4	10.89	43.56	3.24 87.6
North Roof Slab.....	15.75	1:2:4	23.62	94.48	7.09 191.4
South Roof Slab.....	9.38	1:2:4	14.18	56.72	4.22 113.8
Window Sills.....	0.40	1:2:3	0.65	2.60	0.18 4.9
Total.....			187.81 Bbls.	61.10 Cu.Yds.	115.45 Cu.Yds

Approximate amount of Reinforcing Metal required:

5500 feet $\frac{1}{2}$ -inch round rods..... Weight 4700 Lbs.

6800 feet $\frac{3}{8}$ -inch round rods..... Weight 2550 Lbs.

250 feet $\frac{1}{4}$ -inch round rods..... Weight 50 Lbs.

Total..... 7300 Lbs.

(Add about 10 per cent to allow for waste in cutting.)

Forms for the roof beams and slabs and that portion of the columns above the lower beams, are then put up for a distance sufficient to include four panels. The beam molds are next filled and the roof is concreted to a depth of $3\frac{1}{2}$ inches. When temporarily discontinuing work, concreting should be stopped directly over a beam, in the manner shown in Figure 122, Diagram (b). The reinforcing should not be severed at the point where concreting is left off. Before resuming work the concrete previously placed should be thoroughly cleaned, moistened and painted with grout.

Proportions (See page 157). Foundations, Column Footings and Apron, Specification C. Columns, Posts, Roof Beams and Lintels, Specification A.

Interior Fittings for Hog Houses

Floors. Concrete hog house floors must be built in such a manner that they can be easily cleaned, and the surface must be rough enough to prevent the animals from slipping. The floor should be rounded up to walls, so as to eliminate all square corners, where dirt usually collects. Make the floor slope toward a central drain, avoiding dips and hollows which hold the water and prevent the floor from drying off rapidly after cleaning. (See chapter on Floors, page 23.) The floors of farrowing pens should be covered with removable board mats, made of 2x4-inch timbers, spaced about $\frac{3}{8}$ -inch apart. These mats need only to cover the corner of the pen where the sow lies down, and should not be nailed or fastened in any way that will prevent removal for cleaning.

Drainage. The hog house floors should frequently be flushed to keep them sanitary. Drainage must be taken care of either by covered conduits or open gutters draining into a cesspool. A sectional view of a gutter and template for making it are shown in Figure 123. If a conduit is preferred it may be placed either in the center or at the side of the passageway and the floor made to slope toward it. It should be wide enough to admit a shovel for cleaning out, and the depth should vary, giving it a slope of $\frac{1}{4}$ -inch to the foot toward the cesspool. Conduits should be covered with reinforced concrete slabs.

Gutters will be found satisfactory if made in about the shape shown and approximately the dimensions given in the figure. Houses with a single row of pens will require one gutter placed in the floor of the passageway on the side adjacent to the pens, while for houses with double rows, a gutter on each side of the passageway will be necessary. A uniform shape will be obtained if the work is finished off with a wooden template similar to that shown in the illustration.

Pens. The pens are conveniently made nearly square in shape, and should have partitions, doors and gates arranged to provide one corner free from drafts, where the sow can make her nest. The feed trough will be conveniently placed along the side parallel to the passageway, and the partition on that side of the pen should be made to swing on hinges, as shown in Figure 126. This arrangement makes it possible to keep the pigs out of the trough while the feed is being put in, greatly simplifying the work.

Partitions. The partitions may be of concrete or of wood. Wire fences are undesirable, because they allow sows in adjoining pens to worry each other, often making trouble at farrowing time. Concrete partitions of unit, monolithic, block or plaster construction have been

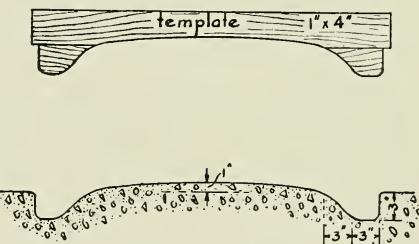


Figure 123. Type of open drain and template for forming the gutter.

used with success and are recommended as preferable to wood. Unit construction should be selected wherever there is an advantage of making the partitions portable.

An ideal partition for monolithic, cement plaster or concrete block structures may be made of reinforced concrete slabs 2 inches thick, 12 inches in width and of convenient length to fit the space to be filled. These may be slipped into slots made of 3-inch, 4-pound channel iron, fastened to the walls and columns by countersunk screws secured to wooden blocks or expansion bolts placed in the wall when the latter are put up.

In the case of monolithic structures, concrete slab partitions may be constructed without the use of channel iron by casting vertical slots in the walls and posts. The slots should extend up 3 feet 6 inches from the floor line, and the top 8 inches should be deep enough to allow the slab to slip in or out. These should be provided in the same manner as for the small unit shelter house described elsewhere in this booklet. The illustration, Figure 125, indicates the methods of fastening channel bars to the wall, and of casting the slots or recesses in walls and columns.

Fenders. To prevent the young pigs from being crushed by the sows during the first few weeks, fenders, or guard rails, should be provided for at least three sides of all brood pens. These fenders must be 8 to 10 inches above the floor and extend out about 8 inches from the wall.

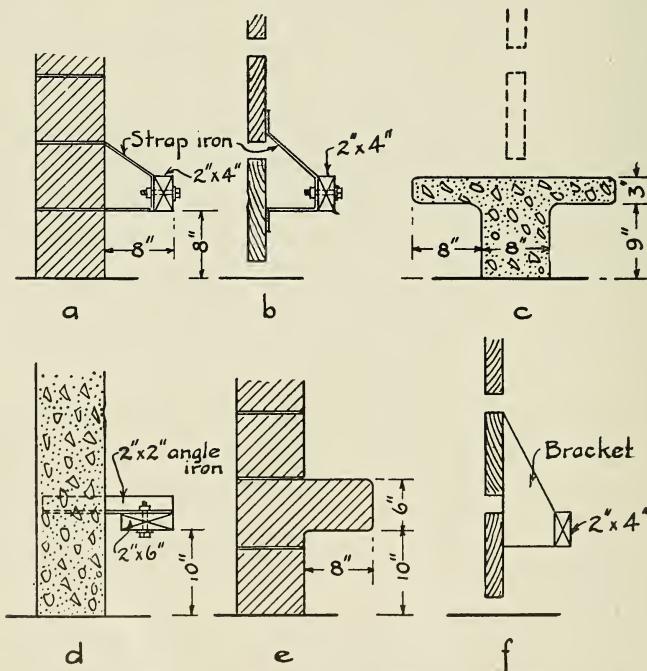


Figure 124. Several Types of Fenders or Guard Rails suggested for use in concrete hog houses.

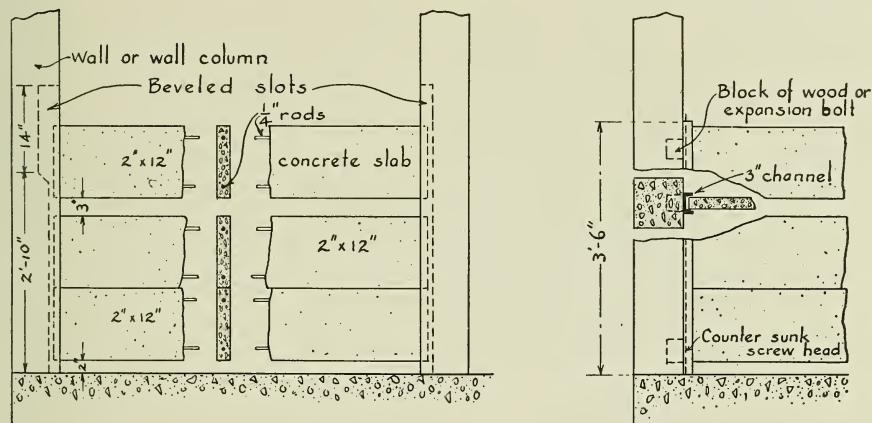


Figure 125. Concrete Slab Partition, made of 2 by 12-inch slabs, which fit into slots cast in the walls, or 3-inch channel iron screwed to wood blocks or wall plugs.

They must be heavy enough to support the weight of the sow, and should have no sharp corners. Figure 124 shows six types of fenders and fender hangers which can easily be adapted to average requirements. Sketch A shows a fender made of two-by-fours with strap iron hangers, suitable for use with block walls; sketch E shows the use of specially shaped fender blocks laid in block walls; C shows a double fender block to be used below concrete slab or plank partitions, and D a fender with angle iron hanger for monolithic walls; B and F show two-by-four fenders with strap iron and wooden bracket supports.

Gates. In hog houses having a row of pens on each side of the passage, there is an advantage in hanging pen gates directly opposite each other. If this be done, any pair of opposite gates may be swung back until they meet or overlap, and then fastened to act as a barrier when the animals are being moved from one pen to another. If the gates are hung 6 inches above the floor, young pigs will be able to get into the passage for exercise. Boards of proper size may be made to slip into slots below the gates to be used when it is desired to keep the pigs within the pens.

Troughs. The troughs for a concrete hog house should always be of concrete. Steel or iron quickly rusts and leaks; wood absorbs the moisture, becomes sour and rots. Forms for concrete troughs are easy to build, and can be made of odd ends of lumber at no additional expense. The trough shown in Figure 126 will be satisfactory for use in any of the hog houses here described, being of convenient size and having a capacity of about $2\frac{1}{2}$ gallons.

A form for casting a trough upside down, using an earth core, is shown in sketch B, Figure 127. On a concrete floor, or after leveling off a plat of ground somewhat larger than the proposed trough, build up the core, approximately to shape, out of plastic earth or clay, using the template as a gauge. The bottomless box can then be placed. If on the ground, stakes should be driven about the form to insure it against

movement in any direction; if on a concrete floor, the box may be held in position with weights, or by braces secured to some nearby object. The core is then worked up to the exact shape desired by using the form as a guide for the template. In this manner uniform thickness is insured on each side. The height of the core will be equal to the depth of the trough, and the height of the template will be equal to the height of the trough. Considerable care must be exercised in working around the earth core, to see that it is not damaged. A shield should be provided to prevent the fresh concrete from knocking off pieces of the core, thus producing an irregular inner surface.

The trough shown in sketch D is similar in construction to that shown at "B" with the exception that a wooden core is substituted for the one of earth and the casting is done on a wooden pallet instead of on the ground.

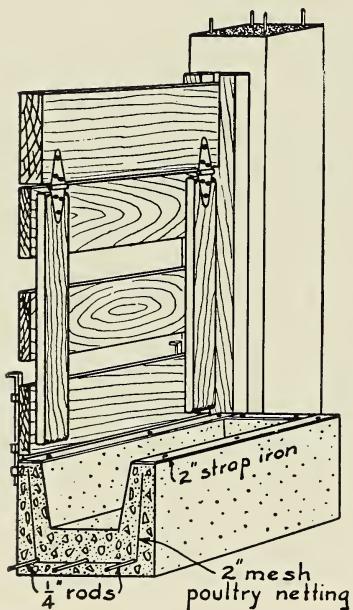


Figure 126. Concrete Trough and Trough Gate to prevent hogs from getting to trough while the slop is being put in. For the houses described in this booklet, troughs should be 12 inches wide, 10 inches high and 4 feet long, with a depth of 6 inches.

of cement, 3 cubic feet sand and 5 cubic feet of gravel or crushed stone will be required.

The trough shown in sketch "E" can readily be cast on a wooden pallet or in place such as on a solid foundation or a concrete floor. In the latter two cases the wooden pallet will be omitted.

After the reinforcing and concrete for the base of the trough has been placed, the remaining concrete must be worked into place with a trowel and struck off with the template. A mortar top is then placed with the trowel and finished to a smooth surface.

The reinforcing for troughs consists either of poultry netting or $\frac{1}{4}$ -inch iron rods, or a combination of the two. Where the tank is to be moved after being made, both the poultry wire and rods are recommended as shown in sketch "C." The spacing of the rods may vary somewhat but will generally be about 4 inches center to center.

Where the trough is cast in place and will never be moved, either the rods or poultry netting is sufficient.

Since the troughs are all of approximately the same section, the capacity will vary only with the length, and for each 10 feet of length about $1\frac{1}{2}$ sacks

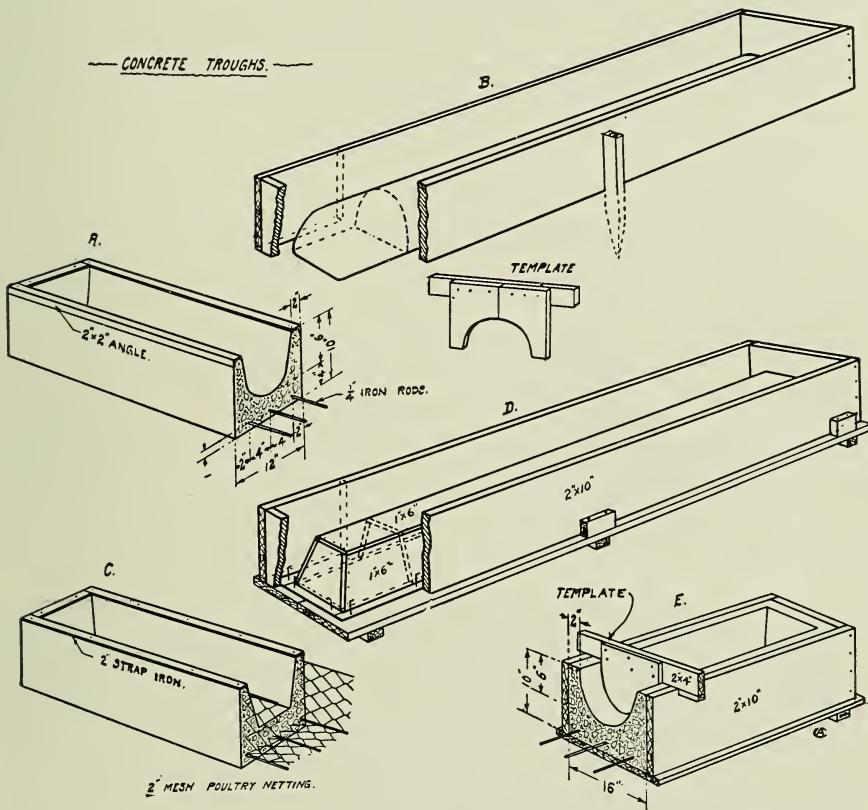


Figure 127. Concrete Troughs suitable for use in concrete hog houses.

Concrete Root Cellars

IN most of the Northern States root cellars are commonly used for the storage of potatoes, turnips and other vegetables from the time of gathering until marketed. Such cellars are also used for the storage of roots which are fed to cattle.

Concrete is an ideal material with which to construct root cellars, because it will not rot out or wear out, as will most other substances. Many of the first cellars were constructed of wooden planking, but experience has shown that this material cannot be depended upon for any considerable length of time, because, being surrounded and covered with earth, the planks are always moist, and beside being affected by the moisture, bow out of place from the pressure of the dirt. It is quite general practice, however, to build root cellars so that the floor is a few feet below the ground line and with this construction it is not necessary to bank the ground up so high around them. In a few cases root cellars have been built with floors on the ground level and dirt has been banked up around the cellar so as to completely cover it, effectually protecting the walls from the heat of the sun.

It is a good plan to provide several openings in the roof through which the vegetables may be shoveled when filling the cellar. These openings need not be larger than 2 feet square, and should be provided with suitable covers to fit tightly into place when not in use. A ventilator should also be provided in the roof of the cellar.

The space beneath the approach to the second floor of a barn is often utilized for the storage of roots. With such an arrangement it



Figure 128. Concrete Root Cellar, University Farm, St. Paul, Minnesota.

is possible for wagons to stop on the approach and unload the vegetables directly through the opening. A root cellar so located is convenient to the barn and double use is thereby made of the walls, which also take the place of retaining walls for the approach. The design of the arch top root cellar shown in Figure 130, page 148, closely follows that suggested in Bulletin No. 90, by Professors J. H. Shepperd and O. O. Churchill of the North Dakota Experiment Station, while the second design, of a small flat top cellar, was recently prepared by our Information Bureau in answer to an inquiry. Additional information regarding root cellars can be secured by addressing Professor J. H. Sheppard or Professor R. M. Dolve of the North Dakota Experiment Station at Fargo.

Reinforced Concrete Root Cellar with Arched Roof

THE design presented in Figure 130 is for an arched top root cellar with a capacity of 5000 bushels when the bins are filled to a height of 6 feet. Larger or smaller cellars may be built without any other alteration to the plan than to lengthen or shorten the building as desired.

The footings upon which the walls rest are 12 inches broad and 12 inches deep, the top of the footings being 6 feet 6 inches below ground level, as shown in section A-A, Figure 130. The inside wall forms are constructed of 2 by 6's running horizontally braced by 2 by 4's running vertically and spaced 18 inches center to center. The 2 by 4's extend from the top of the wall to the sub-grade. The column forms are constructed of two 2 by 10-inch and two 2 by 8-inch boards, and rest on the column footings, forms for which are shown in Figure 112, page



Figure 129. A Good Concrete Root Cellar, on Iowana Farm, near Davenport, Iowa. The cellar is almost entirely below ground, and has a reinforced concrete arched roof.

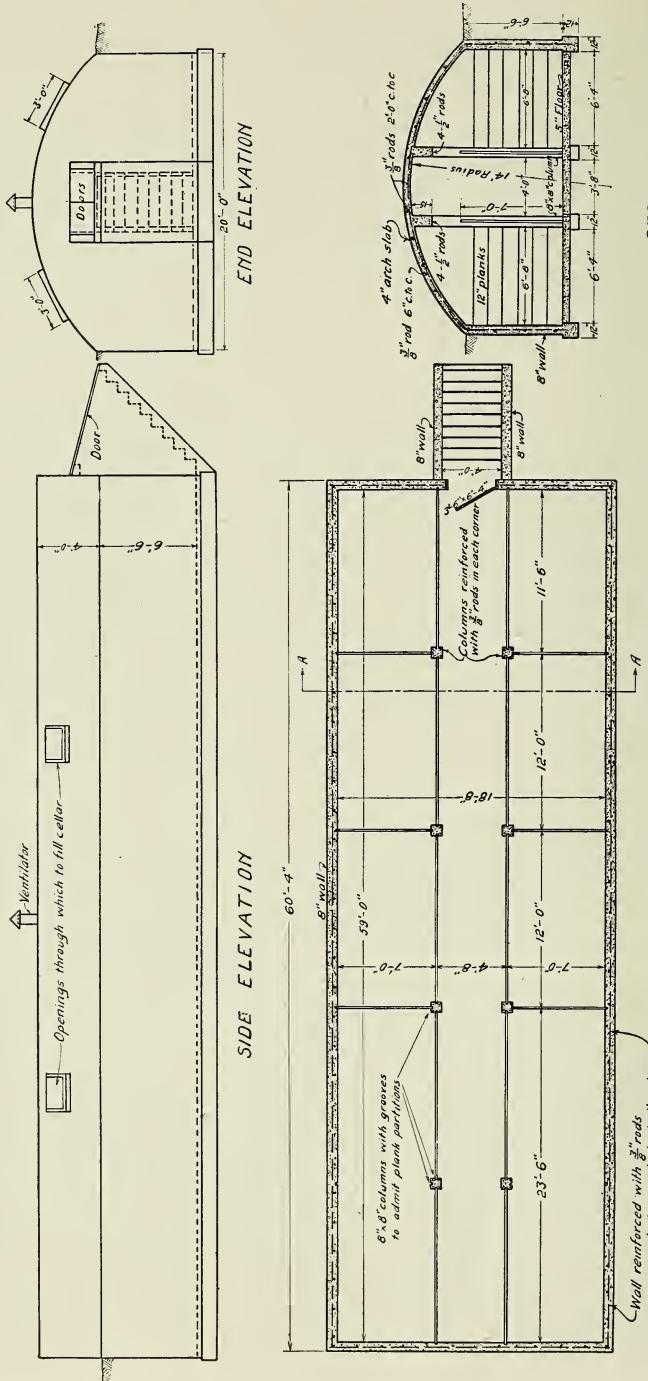


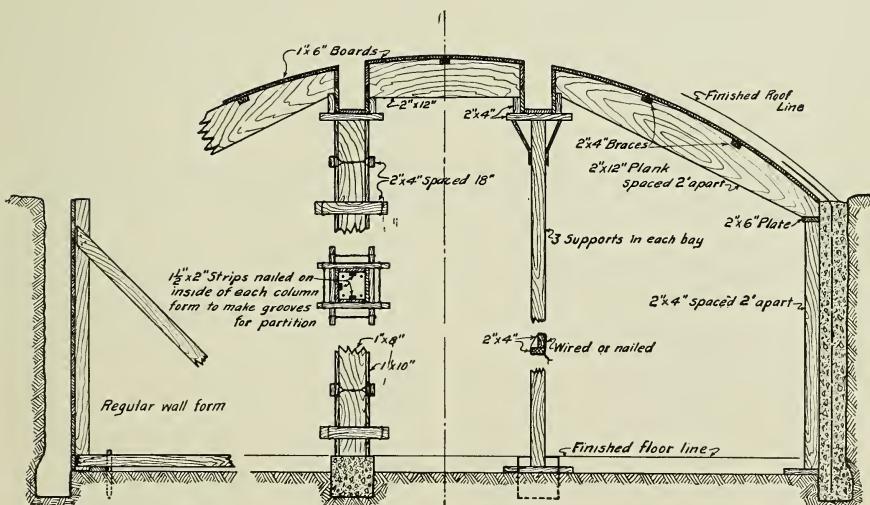
Figure 130. Plan and Elevation of an Arch-Top Root Cellar of Reinforced Concrete Construction. Adapted from a design by Prof. R. M. Dove, of the North Dakota Experiment Station.

127. The column forms are braced by 2 by 4's placed on opposite sides of the column, and wired together as shown in Figure 131. The 2 by 4's should be spaced no farther than 18 inches apart, center to center.

The girder forms are constructed of 2 by 6 inch boards and are supported by two 2 by 4's wired together, there being two such supports between each column. These supports may rest on blocks or flat stones, and can be brought to the desired height by wedges. On the girder forms are blocks fastened to support the three 2 by 12's as shown. The 2 by 12-inch pieces can be cut to shape by the following method: Draw a circle on the barn floor with a radius 2 inches less than the radius required to give the proper curvature to the arch roof, which is 14 feet. For this purpose use a sweep with a soft pencil attached to one end. Do not use cord and chalk as the former will stretch enough to distort the circle and the latter will make too wide a line.

The concrete should be mixed to such a consistency that it will flow readily to all parts of the forms with very little puddling or churning. It should be well spaded to force the larger stones back from the surface and bring the finer material to the surface, thus producing a more dense concrete. The roof slab and girder should be cast in one operation, the forms (shown in Figure 131) having been designed with that idea in view.

The reinforcing for the wall consists of $\frac{3}{8}$ -inch round rods spaced 24 inches apart, center to center, both vertically and horizontally. The roof is reinforced with $\frac{3}{8}$ -inch round rods spaced 6 inches, center to center, in a crosswise direction, and 2 feet, center to center, longitudinally. The forms should be left in place from two to three weeks after the placing of the concrete, or until all doubts have been removed as to the ability of the structure to carry the loads to be imposed upon it.



FORMS FOR CASTING WALL,

FORMS FOR CASTING ROOF WITH SIDE WALLS CAST

Figure 131 Sectional Detailed View of Root Cellar Wall and Forms.

Four openings, each 3 feet square, are provided in the roof, through which the cellar may be filled. Concrete casings for these openings may be easily formed, and should project about 2 inches above the surface so that a cover with a rim surrounding the casing may be placed on when the opening is not in use. The casing may be made with the aid of a small box mold. The ventilator shown in the figure should also be in place before concreting. The concrete stairway should preferably be covered with doors, so as to keep out snow and rain.

The interior is divided into a central alleyway, 4 feet 8 inches wide, and ten storage bins, five on either side of the alley. This arrangement gives bins of convenient size, but any other arrangement desired can easily be worked out. The plank partitions are held in place by grooves in the walls and in the posts, making them readily removable.

Table of Materials

	Cu. Yd.	MIX-TURE	CEMENT Bbls. Sacks	SAND Cu.Yds. Cu.Ft.		GRAVEL Cu.Yds. Cu.Ft.	
Footings.....	5.68	1:2½:5	7.40 29.60	2.62	70.70	5.24	141.50
Column Footings.....	0.30	1:2½:5	0.39 1.56	0.14	3.78	0.28	7.56
Floors.....	16.70	1:2½:4	23.20 92.80	8.52	230.00	13.70	370.00
Walls including entrance way	27.90	1:2½:4	38.80 155.20	14.60	395.00	22.90	618.00
Stairs.....	0.89	1:2½:4	1.25 5.00	.45	12.20	.73	19.70
Columns.....	1.15	1:2:4	1.50 6.00	0.53	14.30	1.06	28.60
Beams.....	3.64	1:2:4	5.72 22.88	1.60	43.20	3.20	86.40
Roof.....	16.18	1:2:4	24.21 96.84	7.13	192.30	14.26	384.50

Total..... 102.47 Bbls. 35.60 Cu.Yds. 61.37 Cu.Yds.

Approximate amount of Reinforcing required:

5200 feet $\frac{3}{8}$ -inch rods..... Weight 1950 Lbs.

482 feet $\frac{1}{2}$ -inch rods..... Weight 322 Lbs.

Total..... 2272 Lbs.

Reinforced Concrete Root Cellar with Flat Slab Roof

IN most cases where a small root cellar is required the design shown in Figure 132 will probably answer. The cellar consists of a rectangular room or cave with wing walls extending across the front, to retain the dirt fill around the structure and prevent it from working down around the doorway. The cellar may be located wholly, or partially, below ground as desired, but the load upon the roof slab should be limited to the weight of 2 feet 6 inches of dirt, or its equivalent. If the cellar is located below ground it must not be driven over. This cellar is of such a design that it may be made larger or smaller by merely changing the length.

The footings, which must be located below the frostline, need be only 9 inches in depth and 14 inches in width. They may be constructed without forms, but the top should be leveled off sufficiently to provide a

good base for the wall forms. The walls should be made 8 inches thick to withstand the pressure of the earth from without.

The door opening in the front wall of the structure should be 3 feet in width and 6 feet in height, and may be formed by placing within the wall forms a suitable frame. The concrete above the doorway in

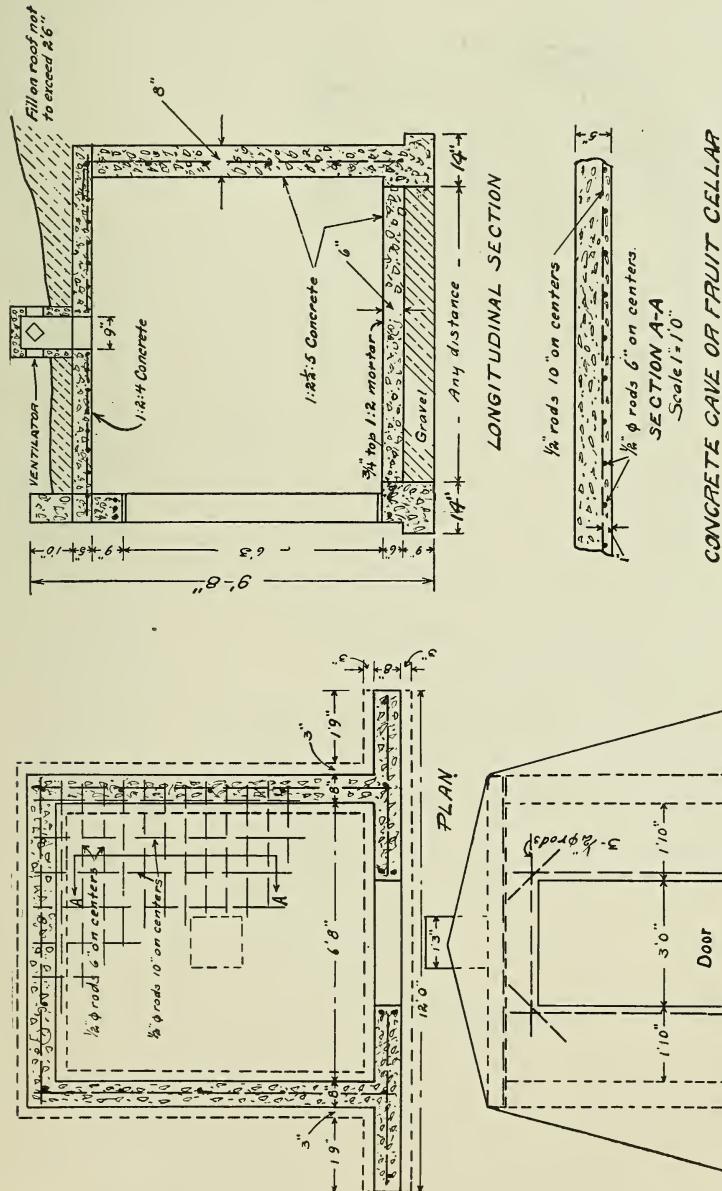


Figure 132. Plan and Elevation of a Flat Top Reinforced Concrete Root Cellar.



Figure 133. Monolithic Root Cellar with Wing Walls, on a Minnesota Farm, property of E. J. Longyear, Minneapolis.

the front wall will act as a beam, and should be reinforced with three $\frac{1}{2}$ -inch round rods as shown in the elevation and longitudinal section.

The roof slab should be made 5 inches thick, and should be reinforced with $\frac{1}{2}$ -inch round rods spaced 10 inches apart, center to center, from front to back of the structure, and 6 inches apart, center to center, in a crosswise direction. The spacing of 10 inches, center to center, will be maintained regardless of the length of the

cellar. All reinforcing rods in the roof should be bent so that the ends will extend down into the walls a distance of 12 inches. The roof should be provided with a small ventilator. For further instructions as to the construction of the roof, the reader is referred to pages 58 to 67.

Proportions (See page 157).

Footings and Base of Floor, Specification D.

Walls, Specification C.

Roof, Specification B.

Surface Coat for Floor, 1:2 cement and sand mortar.

Table of Concreting Materials

	Cu. Yds Concrete	MIX- TURE	CEMENT Bbls. Sacks	SAND		GRAVEL		
				C.Yds.	Cu.Ft.	Cu.Yds.	Cu.Ft.	
Footings.....	1.95	1:2 $\frac{1}{2}$:5	2.42	9.68	.90	24.40	1.80	48.60
Floor { Base.....	2.23	1:2 $\frac{1}{2}$:5	2.77	11.08	1.03	27.80	2.06	55.80
Walls.....	10.7	1:2 $\frac{1}{2}$:4	14.86	59.44	5.45	147.00	8.77	237.00
Roof.....	2.66	1:2:4	4.03	16 12	1.19	32.00	2.37	64.00
Total.....				25.17	Bbls. 8.90	Cu.Yds. 15.00	Cu.Yds.	

Total..... 25.17 Bbls. 8.90 Cu.Yds. 15.00 Cu.Yds.

Steel required for Roof Reinforcing:

40 $\frac{1}{2}$ -inch round rods, 8 feet long..... Total Length 320 Feet (Cross Reinforcing)

10 $\frac{1}{2}$ -inch round rods, 21 feet long..... Total Length 210 Feet (Longitudinal Reinforcing)

Total..... 530 Feet = 354 Lbs. Steel.

Concrete Machine Sheds

IT is a well known fact that the farmers of this country are extremely negligent when it comes to the matter of protecting their farming implements. Even the largest and most expensive pieces of machinery, such as harvesters and traction engines, are frequently seen standing out exposed to the weather, resulting in an enormous annual loss through depreciation. The International Harvester Co. states that experience shows 75 per cent of the annual depreciation is due to exposure to the weather, while only 25 per cent is due to wear and tear. This means that by keeping farm machines in a good dry house and otherwise caring for them when not in use, their period of usefulness can be increased to three or four times the life of the machines left exposed to the weather.

Occasionally space is provided in the barn for the storage of the implements, but in most cases room for storage purposes is at a premium, and the arrangement of the barn makes it necessary frequently to move stored implements from one location to another in order to facilitate the work. This and other considerations make it desirable to store all machinery, tools, etc., in a building especially designed and built for the purpose.

The size and shape of the implement house should conform to the number and size of the objects to be stored. For this reason it is difficult to present in a single design anything likely to be applicable in a large number of cases. The house may be made with either all four sides closed, or with one side open. In case the house is put up with an open side, this side should be to the south or the east, to admit the sun and keep out winter storms which generally come from the north or the west. In houses having all four sides closed, several large doors should be provided along one side to facilitate the movement of implements in and out. To give plenty of room for the larger implements, the house should be about 16 feet deep and the distance between columns or upright supports should be about 12 feet to take in the widest machines. The roof need not be over 8 feet in height and may be lower if desired. The house should be built long and low, somewhat after the general lines of a wagon shed. Future additions can be added to the end, thus giving the house the advantages of a unit structure.

In a recent number of the Dakota Farmer, W. Leonard, of Spink County, South Dakota, describes his machine shed in the following words:

"This shed is 84 feet long and 16 feet wide, standing on slightly sloping ground. The wall is 6 inches thick, made of concrete. The foundation at the high corner is 6 feet high, and the lower corner is 3 feet high.

"Will tell you what we have in this shed at present: The first three apartments are 12 feet, from center to center of posts, and the other six are 8 feet. In the first apartment on the north end, there are two 11-foot grain drills, one broadcast seeder, two listers and a walking plow; in the second a disc, manure spreader, corn planter and gang plow. In the third are two grain binders and bottoms for plows; and in the first two 8-foot apartments are two farm wagons. In the third and fourth are a corn binder, a corn plow, top buggy and a surrey. The south end is used as a repair shop, where a little of everything is at hand. Overhead in this shed is plenty of room for seed corn, side-boards, tongues, binder canvases and other things."

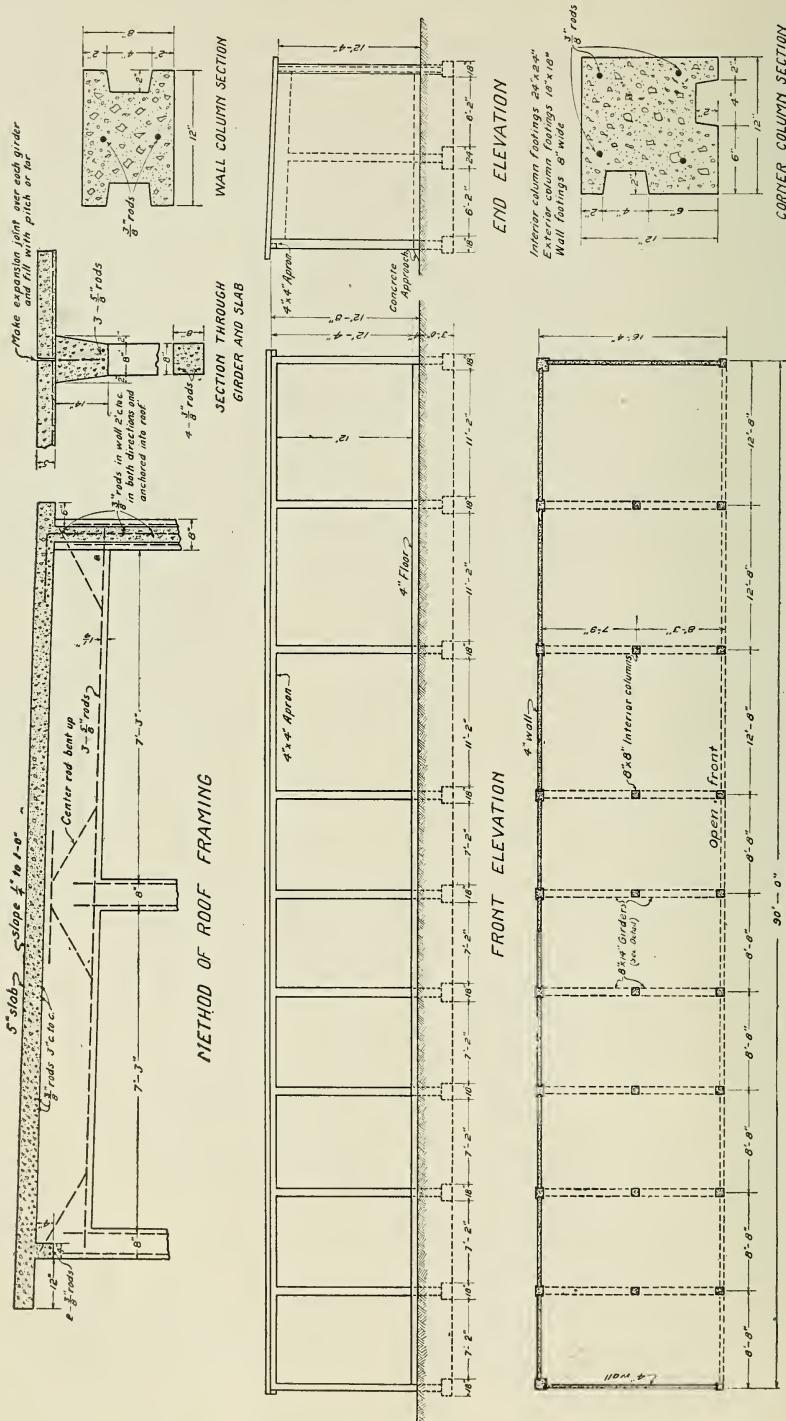


Figure 134. Reinforced Concrete Machine Shed.

A Modern Concrete Machine Shed

THE all-concrete machine shed, shown in Figure 134, was designed from Mr. Leonard's description and may be changed in size to accommodate a larger or smaller number of implements without varying but slightly from this general plan.

The foundations are of concrete with footings 18 inches square. These support 8 by 8-inch reinforced concrete columns grooved to hold in place the concrete slabs which are cast between them. These columns may be cast in a mold similar to that shown in Figure 122, page 140, and the slabs may be cast in ordinary wall forms such as are described on pages 32 to 35. If desired, the walls may be built of concrete blocks without wall columns, although a greater quantity of materials will be required if this be done. It is also possible to use columns, filling up the panels between them with veneer block, 4 inches thick, or with cement plasterwalls.

The roof is of beam and slab construction, and is supported entirely on the columns. After the columns have been placed in position, the forms for the roof beams and slabs are put up, and the beams and slabs concreted. It will be noticed that the reinforcing in the columns protrudes about 8 inches up into the roof beams for the purpose of securely tying the columns and beams together. The reinforcing of the interior columns and beams, as well as the expansion joints in the slab over each beam, is shown in the section through the girder and slab.

After the walls and roof are constructed, a concrete floor 4 inches thick should be laid. For work of this kind a one-course floor is desirable. The floor should be finished off with a wood float and a small amount of mortar used if necessary to secure a sufficiently smooth surface. The floor should be given a slight pitch toward the front of the structure in order to insure good drainage, in case it is desired to wash vehicles within the shed.

Proportions (See page 157).

Foundations, Footing, Apron and Walls, Specification D.

Floors, Specification C.

Columns, Beams and Roof, Specification B.

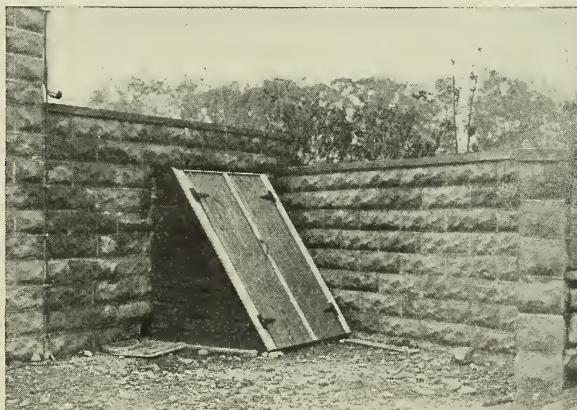


Figure 135. Entrance to Concrete Root Cellar of Mrs. Gallup, Rochester, Wisconsin.

Table of Materials

	VOL. Cu. Yds	MIX- TURE	CEMENT Bbls. Sacks	SAND Cu.Yds. Cu.Ft.	STONE Cu.Yds. Cu.Ft.
Foundations and Footings...	6.83	1:2½:5	8.49 34.00	3.15 71.77	6.31 170.40
Apron.....	.38	1:2½:5	.47 2.00	.18 4.85	.35 9.45
Walls.....	17.20	1:2½:5	21.35 85.40	7.90 213.00	15.85 428.00
Floors.....	17.30	1:2½:4	24.05 96.20	8.82 238.50	14.20 383.00
Columns.....	7.10	1:2:4	10.75 43.00	3.20 86.50	6.30 170.00
Beams.....	4.50	1:2:4	6.80 27.00	2.02 54.50	4.00 108.00
Roof Slab.....	24.40	1:2:4	37.00 148.00	11.00 297.00	21.80 578.00

Total..... 98.91 Bbls. 36.27 Cu.Yds. 68.81 Cu.Yds.

Approximate amount of Reinforcing required:

408 feet, $\frac{5}{8}$ -inch round rods..... Weight 430 Lbs.

8736 feet $\frac{3}{8}$ -inch round rods..... Weight 3300 Lbs.

Total..... 3730 Lbs.

(Add 10 per cent extra steel to allow for waste.)



Figure 136. Monolithic Root Cellar on the Farm of J. S. McMillan, Republic, Missouri. The arched concrete walls of the cellar proper are covered with earth, leaving only the entranceway visible.

APPENDIX

Specifications for Portland Cement Concrete

Specification A—1:2:3

Proportions: 1 sack Portland cement to 2 cubic feet coarse, clean sand, to 3 parts screened gravel or crushed stone, varying in size from $\frac{1}{4}$ inch to 1 inch.

Materials required for 1 cubic yard of concrete: 1.74 barrels (7 sacks) cement, .52 cubic yards (14 cubic feet) sand, .77 cubic yards (20 cubic feet) stone.

Suitable for the walls and floors of tanks and other work requiring watertight concrete of great strength; also sills and lintels without mortar surface.

Specification B—1:2:4

Proportions: 1 sack Portland cement to 2 cubic feet coarse, clean sand, to 4 parts screened gravel or crushed stone varying in size from $\frac{1}{4}$ inch to 1 inch.

Materials required for 1 cubic yard of concrete: 1.51 barrels (6 sacks) cement, .75 cubic yards (21 cubic feet) sand, .89 cubic yards (24 cubic feet) stone.

For roof slabs, beams and columns sustaining great weight.

Specification C—1:2 $\frac{1}{2}$:4

Proportions: 1 sack Portland cement to $2\frac{1}{2}$ cubic feet coarse, clean sand, to 4 parts screened gravel or crushed stone varying in size from $\frac{1}{4}$ inch to 1 inch.

Materials required for 1 cubic yard of concrete: 1.39 barrels (5 $\frac{1}{2}$ sacks) cement, .51 cubic yards (14 cubic feet) sand, .82 cubic yards (22 cubic feet) stone.

For the body of concrete blocks, sills and lintels which are given a mortar surface, walls less than 6 inches in thickness, one-course floors and pavements.

Specification D—1:2 $\frac{1}{2}$:5

Proportions: 1 sack Portland cement to $2\frac{1}{2}$ cubic feet coarse, clean sand, to 5 cubic feet screened gravel or crushed stone varying in size from $\frac{1}{4}$ to $1\frac{1}{2}$ inches.

Materials required for 1 cubic yard of concrete: 1.24 barrels (5 sacks) cement, .46 cubic yards (12.4 cubic feet) sand, .92 cubic yards (25 cubic feet) stone.

For foundations and ordinary walls greater than 6 inches in thickness.

Specification E—1:3:6

Proportions: 1 sack Portland cement to 3 cubic feet coarse, clean sand, to 6 cubic feet screened gravel or crushed stone varying in size from $\frac{1}{4}$ to 2 inches.

Materials required for 1 cubic yard of concrete: 1.06 barrels (4 sacks) cement, .47 cubic yards (12.7 cubic feet) sand, .94 cubic yards (25.4 cubic feet) stone.

Lean mixture for use only where mass rather than strength is required. Suitable for sub-base for tanks and similar work.

Consistency of Concrete

FOR the foundations and walls of buildings enough water should be used in the concrete so that it will flow to all parts of the mold with a small amount of puddling and spading. For columns, beams, floor slabs and roof slabs, the mass should have a quaky consistency such as will tend to flatten out of its own weight when piled. The mortar surfaces of floors should be mixed with sufficient water to make it work easily, but an excess of water should be avoided. Concrete blocks, sills, and lintels should be mixed just as wet as possible with the block machine employed. Blocks and sills made of a mixture wet enough to be quaky when placed in the mold will be dense and watertight. Blocks made with dry materials are porous, lack strength, and present a dead appearance. It must always be remembered that the bonding quality of cement in concrete depends upon a hydraulic action between the cement and the water in which each plays an equally important part. The lack of sufficient water to complete this action is therefore as detrimental as the lack of cement.

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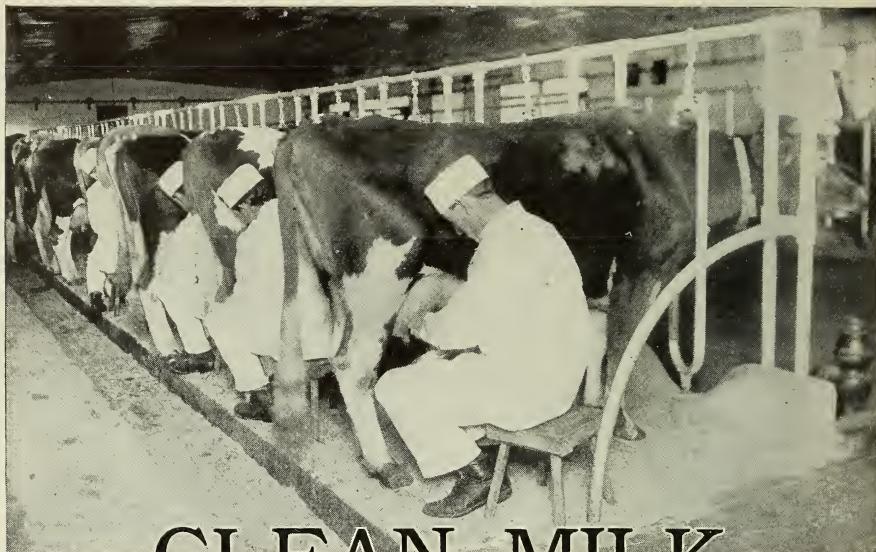
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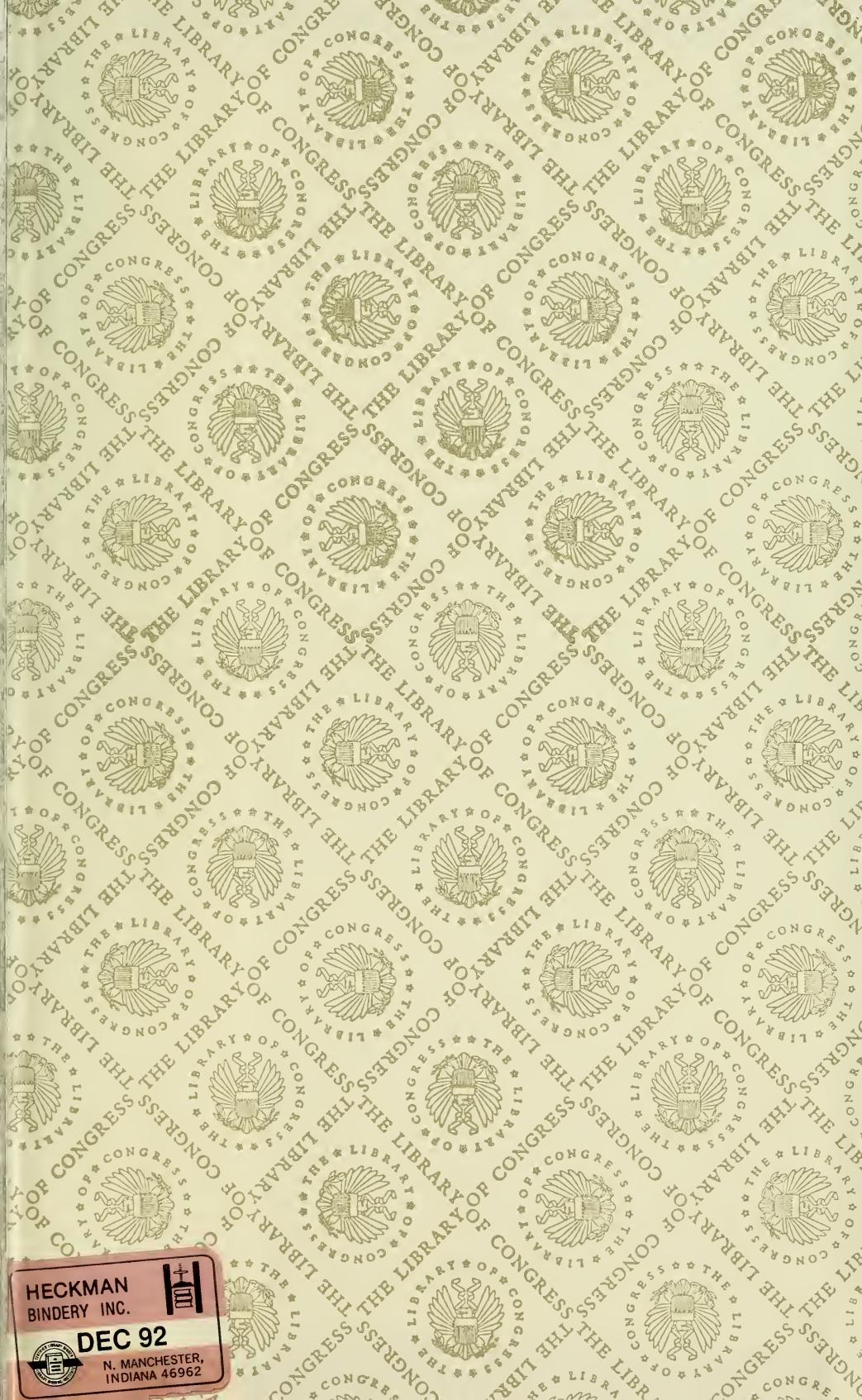
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